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Thomas H. Huxley

YEAR-BOOK OF FACTS

IN

Science and Art

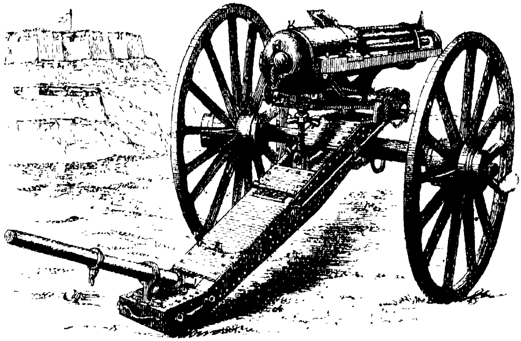
EXHIBITING

E MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS
OF THE PAST YEAR

MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY;
ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY
AND MINERALOGY; METEOROLOGY AND ASTRONOMY.

By JOHN TIMBS,

HOR OF "CURIOSITIES OF SCIENCE," "THINGS NOT GENERALLY KNOWN," ETC.



The American Gatling Mitrailleuse. (See p. 25.)

LONDON:
OCKWOOD & CO, 7 STATIONERS'-HALL COURT.
MDCCCI

PROFESSOR HUXLEY, F.R.S.

PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, 1870.

The election of this distinguished philosopher to the Presidential Chair of the Meeting of the British Association, at Liverpool, in September last, gave assurance of success; the result was one of the best meetings of the Society remembered. The new President was already widely known to the scientific world and the general public by the introduction which he received by the honorary degree of Doctor of Laws from the University of Edinburgh, when Professor Muirhead, who acted as orator, said: "I present to you, Mr. Vice-Chancellor, as judged worthy by the Senate to receive the honorary degree of Doctor of Laws, Mr. Thomas Henry Huxley, a Fellow of the Royal Society, Professor of Natural History at the School of Mines, and Hunterian Professor of Comparative Anatomy in the Royal College of Surgeons of England. Trained to the medical profession, Mr. Huxley became in early life an assistant-surgeon in the Royal Navy; and it was while serving in that capacity in one of her Majesty's ships, then engaged in a survey of the coasts of Australia and New Guinea, that he acquired his unrivalled knowledge of marine zoology, and vindicated his claims to be regarded as one of the most accomplished naturalists of the day. His appointment soon after his return to this country to the Chair of Natural History in the Government School in Jermyn Street, gave him the opportunity of turning his attention to palæontological inquiries; and the results of his labours in that field are embodied in a series of valuable and most interesting papers descriptive of various extinct forms of animals. As Hunterian Professor in the College of Surgeons of England, he has delivered several courses of lectures on the comparative anatomy of the vertebrata, lectures which, not less than his contributions to the Transactions of learned Societies, testify to his remarkable perspicuity and his rare power of discriminating the relations of structures in complicated forms of animal life."

The first general meeting was held on Wednesday, in the Philharmonic Hall, Liverpool. The retiring president, Professor Stokes, vacated the chair to Professor Huxley, who then delivered the customary address.

The Professor commenced by an allusion to the custom which calls upon the President of the Association to furnish a report of the general progress of science, as seen from the elevation upon which the suffrages of his colleagues had for the time placed him; and expressed his own intention to follow, in some degree, this ancient precedent. He would not attempt a panoramic survey, but would endeavour to put before his hearers the history of the rise and progress of a single biological doctrine.

It is a matter of everyday experience that it is difficult to prevent many articles of food from becoming covered with mould; that fruit, sound enough to all appearance, often contains grubs at the core; that meat, left to itself in the air, is apt to putrefy and swarm with maggots. Even ordinary water, if allowed to stand in an open vessel, sooner or later becomes turbid and full of living matter. The philosophers of antiquity, when interrogated as to the cause of these phenomena, were provided with a ready and plausible answer. It did not enter their minds even to doubt that these low forms of life were generated in the matters in which they made their appearance, and the proposition that life may, and does, proceed from that which has no life was held alike by the philosophers, the poets, and the people of the most enlightened nations 1800 years ago, and remained the accepted doctrine of learned and unlearned Europe through the Middle Ages down even to the seventeenth century.

The first repudiation of it, the first distinct enunciation of the proposition that all living matter has sprung from pre-existing living matter, came from an Italian, Francesco Redi, a man of the widest knowledge and the most versatile abilities, distinguished alike as scholar, poet, physician, and naturalist; who, just 202 years ago, gave to the world the idea which it is my purpose to trace.

He did not trouble himself with speculative considerations, but attacked experimentally what had been considered to be particular cases of spontaneous generation. "Here are dead animals, or pieces of meat," he said; "I expose them to the air in hot weather, and in a few days they swarm with maggots. You tell me that these are generated in the dead flesh; but if I put similar bodies, while quite fresh, into a jar, and tie some fine gauze over the top of the jar, not a maggot makes its appearance, while the dead substances, nevertheless, putrefy just in the same way as before. It is obvious, therefore, that the maggots are not generated by the corruption of the meat; and that the cause of their formation must be something which is kept away by gauze. But gauze will not keep away aëriform bodies or fluids. This something must therefore exist in the form of solid particles too big to get through the gauze. Nor is one long left in doubt what these solid particles are; for the blow-flies, attracted by the odour of the meat, swarm round the vessel, and, urged by a powerful, but in this case misleading, instinct, lay eggs, out of which maggots are immediately hatched upon the gauze. The conclusion, therefore, is unavoidable—the maggots are not generated by the meat, but the eggs which give rise to them are brought through the air by the flies."

Almost childishly simple as these experiments now seem, they were at that time new; and they are worthy of careful study. Every piece of experimental work since done, in relation to this subject, has been shaped upon the model left by the Italian philosopher. And as Redi's results were the same, however varied the nature of the materials he used, it is not wonderful that there arose in his mind a presumption that in all cases of seeming production of life from dead matter, the real explanation was the introduction of living germs from without into the dead matter. It became necessary that this hypothesis should in every case be considered and refuted before the production of life in any other way could be admitted by careful reasoners. The hypothesis will be mentioned so frequently that, to save circumlocution, I shall call it the hypothesis of Biogenesis, and I shall term the contrary doctrine—that living matter may be produced by not living matter—the hypothesis of Abiogenesis.

It is interesting to observe that Redi did not escape the customary tax upon a discoverer of having to defend himself against the charge of impugning the authority of the Scriptures; for his adversaries declared that the generation of bees out of the carcass of a dead lion is affirmed in the Book of Judges to have been the origin of the riddle with which Samson perplexed the Philistines. Against all odds, however, the philosopher did splendid battle in the cause of biogenesis; but he held the doctrine in a sense which, if he had lived in these times, would have caused him to be classed among the defenders of "spontaneous generation." *Omne vivum ex vivo* (no life without antecedent life) aphoristically sums up his doctrine; but he went no farther. He had speculatively anticipated the manner in which grubs are deposited in fruits and in the galls of plants, but he admitted that he had not sufficient evidence to bear him out, and he therefore preferred the supposition that they are generated by a modification of the living substance of the plants themselves. Indeed, he regarded these vegetable growths as organs by which a plant gives rise to an animal, and he looked upon this production of animals as the final cause of galls and of some fruits. He proposed also to explain in the same way the production of parasites within the animal body.

It is of great importance to apprehend Redi's position rightly; for naturalists have ever since been working upon the lines of thought he laid down. Clearly he held biogenesis as against abiogenesis; and I shall immediately proceed to inquire how far subsequent investigations have borne him out in so doing.

But Redi also thought that there were two modes of biogenesis. By one, of common occurrence, the parent gives rise to offspring, which passes through the same cycle of changes as itself, and this has been termed homogenesis. By the other the parent was supposed to give rise to offspring which passed through a different series of states, and did not return into the cycle of the parent. This ought to be called heterogenesis, the offspring being altogether and permanently unlike the parent. The term, however, has been used in another sense; and M. Milne-Edwards has substituted for it xenogenesis, which means the generation of something foreign.

After discussing Redi's hypothesis of universal biogenesis, I shall go on to ask how far the growth of science justifies his other hypothesis of xenogenesis. The progress of biogenesis was triumphant and unchecked for nearly a century. The earlier applications of the microscope to anatomy revealed such a complexity of organisation in the lowest forms of life, and such a prodigality of provision for their multiplication, that the hypothesis of abiogenesis began to appear not only untrue but absurd; and in the middle of the eighteenth century, when Buffon and Needham took up the question, it was almost universally discredited.

But the skill of the microscope-makers of that day soon reached its limits, and an enlargement of 400 diameters, which was the utmost to which they attained, is barely sufficient to display as mere dots and lines a large proportion of the minute active creatures known as infusorial animalcules, which swarm in water containing any animal or vegetable body.

Led by various theoretical considerations, Buffon and Needham doubted the applicability of Redi's hypothesis to the infusorial animacules; and Needham endeavoured to bring the question to an experimental test. He argued that if these creatures were produced from germs, the germs must exist either in the substance infused, or in the water, or in the superjacent air. Now, the vitality of germs is destroyed by heat; and hence, if the infusion were boiled, carefully corked, and the vessel containing it again heated, all germs present would be destroyed. Consequently, on Redi's hypothesis, when the vessels thus prepared were set aside to cool, no animacules should be developed in them; whereas, if animacules are not dependent upon pre-existing germs, but are generated from the substance infused, they ought in time to make their appearance. Needham found, under the circumstances in which he made his experiments, that animalcules always did arise in the infusions.

In much of his work Needham was associated with Buffon, and the results of their experiments fitted with the French naturalist's hypothesis of "organic molecules," according to which life is the indefeasible property of certain indestructible molecules of matter which exist in all living things, and have inherent activities by which they are distinguished from not living matter. Each individual living organism is formed by their temporary combination. They stand to it in the relation of the particles of water to a cascade or a whirlpool, or to a mould into which the water is poured. The form of the organism is thus determined by the reaction between external conditions and the inherent activities of the organic molecules of which it is composed; and as the stoppage of a whirlpool destroys nothing but a form, and leaves the molecules of the water with all their inherent activities intact, so what we call the death and putrefaction of an animal or of a plant is merely the breaking up of the form or manner of association of its constituent organic molecules, which are then set free as infusorial animacules.

It will be perceived that this doctrine is by no means identical with abiogenesis, with which it is often confounded. On this hypothesis a piece of beef, or a handful of hay, is dead only in a limited sense. The beef is dead ox, and the hay is dead grass but the "organic molecules" of the beef or the hay are not dead, but are ready to manifest their vitality as soon as the bovine or herbaceous shrouds in which they are imprisoned are rent by the macerating action of water. The hypothesis, therefore, must be classified under xenogenesis rather than under abiogenesis. Such as it was, I think it will appear to those who will be just enough to remember that it was propounded before the birth of modern chemistry and of the modern optical arts to be a most ingenious and suggestive speculation.

But the great tragedy of science—the slaying of a beautiful hypothesis by an ugly fact —which is so constantly being enacted under the eyes of philosophers, was played almost immediately for the benefit of Buffon and Needham.

The Abbé Spallanzani suggested that Needham's experiments had not been conducted with sufficient care; and showed that a more prolonged exposure of the flasks to an elevated temperature, and a more complete method of closing them, entirely prevented the appearance of animacules. But we all too often forget that it is one thing to refute a proposition, and another to prove the truth of a doctrine that contradicts that proposition; and the advance of science soon showed that, though Needham might be quite wrong, it did not follow that Spallanzani was quite right.

The discovery of oxygen, and some of its relations to the phenomena of life, opened a new aspect to the question, and occasioned doubts as to what might have happened to the organic matter of the infusions, or to the oxygen of the air, in Spallanzani's experiments. What security was there that the development of life had not been checked or prevented by chemical changes? It was needful to repeat the experiments under conditions which would make sure that neither the oxygen of the air nor the composition of the organic matter was altered in such a manner as to interfere with the existence of life.

Schulze and Schwann devised means of accomplishing this, by causing the *only* air which reached the infusions to pass through red-hot tubes or through strong sulphuric acid. They found that an infusion so treated developed no living things, but that if it was afterwards exposed to common air life appeared abundantly. The accuracy of their experiments has been by turns affirmed and denied; but, in any case, they only proved that the treatment to which the air had been subjected had destroyed something that was essential to the development of life in infusions. This something might be solid, fluid, or gaseous; that it consisted of germs remained only an hypothesis of more or less probability.

Contemporaneously with these investigations came the discovery of Cagniard de la Tour, that common yeast is composed of a vast accumulation of minute plants. Thus fermentation, in so far as it is attended by the development of microscopical organisms in enormous numbers, became assimilated to the decomposition of an ordinary infusion: and it was an obvious suggestion that the organisms were, in some way or other, the causes both of fermentation and of putrefaction. The chemists, headed by Berzelius and Liebig, laughed the notion to scorn; but in 1843 it was shown by the since illustrious Helmholtz that the interposition of a membrane between a putrefying or a fermenting liquid and one that was simply putrescible or fermentable prevented the formation of organisms in the latter. Therefore the cause of the development of these organisms must be something that cannot pass through membrane; and when viewed by the light of Graham's subsequent researches upon colloids, Helmholtz's experiments narrowed the issue to this:—That which excites fermentation and putrefaction, and, at the same time, gives rise to living forms in an infusion, is not a gas and is not a diffusible fluid; therefore it is either a colloid, or it is matter divided into very minute solid particles.

The investigations of Schroeder and Dusch in 1854, and of Schroeder alone in 1859, cleared up this point by showing that the exclusion of air from an infusion by a plug of cotton wool prevented putrefaction, fermentation, and the development of organic forms. It is hard to imagine what the fine sieve formed by cotton wool could have excluded, except minute solid particles, but it was reserved for Professor Tyndall to complete the demonstration—first, by showing that ordinary air does contain such particles; and, secondly, that filtration through cotton wool removes them. It has been a common objection to the doctrine of biogenesis that if it were true the air must be thick with germs; and the abiogenists regard this as the height of absurdity. Professor Tyndall has proved that ordinary air is no better than a stirabout of excessively minute solid particles; that these particles are almost wholly destructible by heat; and that they are strained off, and the air rendered optically pure, by passing through a layer of cotton wool.

It remains yet in the order of logic, though not of history, to show that among these solid destructible particles there are germs capable of giving rise to living forms. This was done by M. Pasteur, in those beautiful researches which will ever render his name famous, and which, in spite of all attacks upon them, appear to me to be models of accurate experimentation and logical reasoning.

From the whole chain of evidence it is demonstrable:—That a fluid eminently fit for the development of the lowest forms of life, but which contains no germs, nor any protein compound, gives rise to living things in great abundance if it is exposed to ordinary air; while there is no such development if the air with which it is in contact is mechanically freed from the solid particles which usually float in it, and which may be made visible by appropriate means; that the great majority of these particles are destructible by heat, and that some of these are germs or living particles capable of giving rise to the same forms of life as those which appear when the fluid is exposed to unpurified air; that inoculation of the experimental fluid with a drop of liquid known to contain living particles gives rise to the same phenomena as exposure to unpurified air; and it is further certain that these living particles are so minute that the assumption of their suspension in ordinary air presents not the slightest difficulty. On the contrary, considering their lightness and the wide diffusion of the organisms which produce them, it is impossible to conceive that they should not be suspended in the atmosphere in myriads. On all these grounds, the evidence, direct and indirect, in favour of biogenesis for all known forms of life must be admitted to be of great weight.

On the other side, the sole assertions worthy of attention are that hermetically-sealed fluids which have been exposed to great and long-continued heat have sometimes exhibited living forms of low organisation when they have been opened. It is probable that there must be some error in these experiments, since others similar to them are performed on an enormous scale in the preservation of various kinds of food in tin cases, and with a totally different result.

Even if this were not so, it would by no means follow from the experiments to which I refer that abiogenesis had really occurred. The resistance of living matter to heat is known to vary within considerable limits, and to depend to some extent upon the chemical and physical qualities of the surrounding medium. But if, in the present state of science, we are offered the alternative either of believing that germs can stand a greater heat than has been supposed, or that the molecules of dead matter, for no valid or intelligible reason that is assigned, are able to rearrange themselves into living bodies, exactly such as are frequently produced in another way, I cannot understand how our choice can be even for a moment doubtful.

In expressing this conviction I must, nevertheless, guard myself against the supposition that I intend to suggest that no such thing as abiogenesis has occurred in the past or will occur in the future. I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call "vital" may not some day be artificially brought together. All I feel justified in affirming is that I see no reason for believing that the feat has been performed yet.

Looking back over the past, and finding no record of the commencement of life, I am devoid of any means of forming a definite conclusion as to the condition of its appearance. Belief, in the scientific sense, is a serious matter, and needs strong foundations.

To say that I have any belief as to the mode in which the existing forms of life have originated would be using words in a wrong sense. But expectation is permissible where belief is not; and if it were given to me to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions, which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not living matter. I should expect to see it appear under forms of great simplicity, endowed, like existing fungi, with the power of determining the formation of new protoplasm from such matters as ammonium, carbonates, oxalates, and tartrates, alkaline and earthy phosphates, and water without the aid of light. That is the expectation to which analogical reasoning leads me; but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith.

With these limitations, Redi's great doctrine of biogenesis appears to me to be victorious along the whole line at the present day.

As regards the second problem offered to us by Redi, the hypothesis of xenogenesis, the researches of two centuries have led to a different result. That the grubs found in galls are a result of the introduction of the eggs of insects from without has long ago been clearly proved. The case of animal parasites was long a stronghold of the advocates of the doctrine. But the splendid patience of helminthologists has succeeded within the last thirty years in tracing every such parasite, often through the strangest wanderings and metamorphoses, to an egg derived from a parent actually or potentially like itself, and the tendency of inquiries elsewhere has all been in the same direction.

It is only in pathology that we find any approximation to true xenegenesis; and it is furnished by the various diseased structures in which, under the influence of certain external conditions, elements of the body, which should have developed in due subordination to its general plan, set up for themselves and apply the nourishment which they receive to their own purposes.

From such innocent productions as corns and warts there are all gradations to more serious tumours; and in the terrible structures known as cancers the new growth has acquired powers of reproduction and multiplication, and is only distinguishable by form from the parasite worm, the life of which is neither more nor less closely bound up with that of the infested organism.

If there were a diseased structure, the elements of which were capable of maintaining a separate and independent existence out of the body, it seems to me that the shadowy boundary between morbid growth and xenogenesis would be effaced; and I am inclined to think that the progress of discovery has nearly brought us to this point. The Appendix to the Twelfth Report of the Medical Officer of the Privy Council contains an essay "On the Intimate Pathology of Contagion," by Dr. Burdon-Sanderson, which is one of the clearest, most comprehensive, and well-reasoned discussions of a great question that has come under my notice for a long time. It contains evidence to show that the active element in vaccine lymph is non-diffusible, and consists of minute particles not exceeding 1-2000th of an inch in diameter. Two of the most destructive epizootic diseases—sheep-pox and glanders—are also shown to be dependent for their existence and propagation upon extremely small living particles, to which the name of microzymes is applied. An animal suffering from either is a source of infection to others, for the same reason that a tub of fermenting beer is capable of propagating its fermentation to fresh wort. In both cases it is the solid living particles which are efficient; the liquid in which they float, and at the expense of which they live, being altogether impassive.

It is a question of immense importance to determine whether these microzymes are the results of homogenesis or of exenogenesis, or, in other words, whether they are capable of arising only by the development of pre-existing germs, or of being the results of conditions operating upon the body in which they are found. A parasite may be stamped out by destroying its germs; but a product of disease can only be annihilated by removing the conditions which give rise to it.

It appears to me that this problem must be solved for each zymotic disease separately. I have dwelt upon the analogy of pathological modification, as in favour of the xenogenetic origin of microzymes; and I must now speak of the equally strong analogies in favour of the origin of such pestiferous particles by the ordinary process of the generation of like from like.

It is a well-established fact that certain contagious epidemic diseases, both of plants and animals, are caused by the growth of minute organisms. The smut of wheat is a well-known example.

The common house-fly is frequently destroyed by the growth within its body of a fungus, the Empusa muscæ, which, in flies still apparently healthy, is found to exist in the form of minute corpuscles which float in the blood. These multiply and lengthen into filaments at the expense of the fly's substance, and when they have killed it they grow out of its body and give off spores, which, falling upon other flies, germinate, penetrate the skin, and yield the floating corpuscles when they have entered the body.

It is only very lately that the true course of events has been made out, and until this was done the case looked much like one of abiogenesis, or at least of xenogenesis.

The silkworm has long been known to be the subject of a very fatal contagious and infectious disease called the "muscardine."

This is entirely due to the development of a fungus in the body of the larva. But of late years a still more serious disease has broken out among them. Before 1853 a peculiar epizootic, frequently accompanied by the appearance of dark spots upon the skin (whence it was called "pébrine") had been noted for its mortality. In the year following (1853) it broke out in the South of France with such violence that in 1856 the silk crop was reduced to a third of the amount which it had reached in 1853. This means not only that the great number of people engaged in growing silk are some thirty millions sterling poorer than they might have been, but also that the looms of Lyons have lacked employment, and that for years enforced idleness and misery have been the portion of a vast population which was formerly industrious and well-to-do.

In 1858 the French Government appointed commissioners to inquire into the subject, among whom was M. de Quatrefages. It is interesting to observe that this distinguished naturalist, in his elaborate study of the pébrine, arrived at the conviction that it is in every respect comparable to the cholera among mankind. But it differs from cholera in being hereditary, and in being, under some circumstances, contagious as well as infectious.

The Italian naturalist, Filippi, discovered in the blood of the affected silkworms a multitude of cylindrical corpuscles, each about 1-6000th of an inch long. These bodies have been named by Lebert panhistophyton, because they swarm in every tissue of the body, and even pass into the undeveloped eggs of the female moth.

It has been made quite certain by the researches of M. Pasteur that the pébrine is the result of the growth and multiplication of the panhistophyton in the silkworm; and it is obvious that the means of preventing the disease must depend upon the way in which the panhistophyton is generated. If by abiogenesis, or by xenogenesis, within the silkworm or its moth, the extirpation of the disease must depend upon the prevention of the occurrence of the conditions under which the generation arises. But if the panhistophyton is an independent organism, then the indications are totally different. The sole thing to be done is to get rid of and keep away the germs from which it springs. M. Pasteur was led to adopt the latter theory, and he has devised a means of extirpating the disease, which has proved to be completely successful wherever it has been properly carried out. Analogous evidence is furnished by the investigations of Professor Lister into the causes of mortality after operations; and it seems probable that the surgeon who saves most lives will be he who best works out the practical consequences of the hypothesis of Redi.

I commenced by asking you to follow me in a survey that has not taken us into a very attractive region. Our path has lain chiefly in a land flowing with the abominable, and peopled with mere grubs and mouldiness.

Nevertheless you will have observed that there soon appeared on the right hand and on the left fields laden with a harvest of golden grain, immediately convertible into those things which the most sordidly practical of men will admit to have value—namely, money and life. The direct loss to France caused by the pébrine in seventeen years cannot be estimated at less than 50,000,000*l.* sterling, and if we add to this what Redi's idea, in Pasteur's hands, has done for the wine-grower and the vinegar-maker, and try to capitalise its value, we shall find that it will go a long way towards repairing the money losses of the calamitous war of this autumn. And, as to the equivalent of Redi's thought in life, how can we over-estimate the value of that knowledge of the nature of contagious diseases, and consequently of the means of checking them, the dawn of which has assuredly commenced?

Looking back over only ten years, it is possible to select three (1863, 1864, and 1869), in which the total number of deaths from scarlet fever alone amounted to 90,000. That is the return of the killed, the maimed and disabled being left out of sight. The facts which I have placed before you must leave the least sanguine without a doubt that the nature and causes of this scourge will one day be as well understood as those of pébrine are now, and that the long-suffered massacre of our innocents will come to an end.

And thus mankind will have one more admonition that "the people perish for lack of knowledge," and that the alleviation of the miseries and the promotion of the welfare of men must be sought by those who will not lose their pains, in that diligent, patient, loving study of all the multitudinous aspects of nature, the results of which constitute exact knowledge, or science.

It is the justification and the glory of this great meeting that it is gathered together for no other object than the advancement of the moiety of science which deals with those phenomena of nature which we call physical. May its endeavours be crowned with a full measure of success!

On the conclusion of the address, which was greeted with loud cheers, a vote of thanks to Professor Huxley was proposed by the Earl of Derby, seconded by the Mayor, and carried, in Liverpool fashion, by three cheers—an unusual one for the proceedings of the Association.

Professor Huxley's address was written in the best taste (says the *Athenæum*), devoid of any sentences obnoxious to the most sensitive audience; it was at once abstruse and popular; but the two conditions were combined in language perfectly intelligible to every one.

We add the accompanying biographical data of the scientific career of Professor Huxley, with notices of his published works, for which we, in the main, have to acknowledge our obligation to an able paper in the *Leisure Hour* for September last.

Professor Huxley was born at Ealing, in Middlesex, in 1825, and was educated at Ealing School. He studied medicine with much success at the Medical School of the Charing Cross Hospital; and in 1846, at the age of twenty-one, was appointed assistant-surgeon to H.M.'s ship *Rattlesnake*, then about to sail on a surveying cruise in the Southern seas. A narrative of its progress, on its return, was written by John Macgillivray, with illustrations from drawings made by Mr. Huxley. The first-fruit of these researches was a paper by Mr. Huxley, read to the Royal Society, when he was only in his 23rd year. Next was communicated to the Royal Society Mr. Huxley's paper of "Observations upon Salpæ," those gelatinous animals, through masses of which the voyager on the great ocean sometimes sails day after day.

On his return to England, in 1850, Mr. Huxley was elected a Fellow of the Royal Society. Since his return he has taken an active part in the work of the British Association; among his labours may be mentioned his valuable Report on the Ascidiams in 1852, and his able presidency over the Biological Section of the meeting of the Association at Cambridge.

In April 1852, Mr. Huxley first appeared as lecturer at the Royal Institution, and there for a number of years he gave a lecture yearly, upon "Animal Individuality;" next on the "Identity and Structure of Plants and Animals," in which he directed his remarks to the essential nature of organisation; and in that in 1854, to the "Common Plan of Animal Forms," he referred to a short essay by Goethe—the last which proceeded from his pen, containing a critical account of a discussion bearing upon the doctrine of the unity of organisation of animals which had then (1830) just taken place in the French Academy. Goethe said that for him this controversy was of more importance than the Revolution of July, which immediately followed it; a declaration which might be regarded as a prophecy; for while the *Charte*, and those who established it, have vanished, as if they had never been, the doctrine of the unity of organisation retains a profound interest and importance for those who study the science of life. A lecture "On the Development of Animal Life in Time," was succeeded by another of a most useful and valuable character, "On Natural History as a means of Knowledge, Discipline, and Power." From this last we give the following extract:—"In travelling from one end to the other of the scale of life we are taught that nature is not a mechanism but a power; not a mere rough engine-house for the due keeping of pleasure and pain machines, but a palace whose foundations are laid on the strictest and safest mechanical principles, but whose superstructure is a manifestation of the highest and noblest art. If we have a right to conclude from the marks of beneficent design, to an Infinite Intellect and Benevolence, in some sort similar to our own, than from the existence of a beauty (nay, even of a humour), and of a predominant harmonious variety in unity in nature, which, if the work of man, would be regarded as the highest art, we are similarly bound to conclude that the æsthetic faculties of the human soul have also been foreshadowed in the Infinite Mind." In 1854, when Professor Edward Forbes was elected to the Chair of Natural History in the University of Edinburgh, Professor Huxley succeeded him in the Natural History Professorship at the School of Mines. This position he still holds. In the discharge of its duties he was led necessarily into palæontological inquiries, and as a palæontologist he has taken high rank.

A course of six lectures, "On our Knowledge of the Causes of the Phenomena of Organic Nature," was delivered to working men at the Museum of Practical Geology, Jermyn Street, and afterwards published. In this little work he thus states his views as to the unity of race in man :—"I am one of those who believe that, at present, there is no evidence whatever for saying that mankind sprang originally from any more than a single pair ; I must say that I cannot see any good ground whatever, on any tenable sort of evidence, for believing that there is more than one species of man." Soon after Mr. Huxley became Professor of Comparative Anatomy to the Royal College of Surgeons of England, he published a volume of lectures "On the Elements of Comparative Anatomy." "An Elementary Atlas of Comparative Anatomy" is also designed to assist students. The objects were selected and arranged by Professor Huxley, and drawn on stone by B. W. Hawkins. In twelve plates is shown a comparative view of similar parts of the skeletons of such animals as are more easily accessible. Here we may also mention that to Mr. Samuel Laing's "Pre-historic Remains of Caithness" Professor Huxley contributed an appendix on the skulls found at Caithness, referred to in that work. The volume entitled "Evidence as to Man's Place in Nature" appeared in 1863, and consists of three essays: 1st. "On the Natural History of the Manlike Apes ;" 2nd. "On the Relations of Man to the Lower Animals," and 3rd. "On some Fossil Remains of Man." The substance of the essays had before been published in the form of oral discourses addressed to widely-different audiences. Upon the subject of the second essay two lectures were delivered to the members of the Philosophical Institution of Edinburgh in 1862. This work has been translated into French, German, and Italian.

Some idea may be given of the variety of our author's scientific researches, and of his literary activity, when we say that, in addition to his published works and his professional courses of lectures, he has made, at a moderate estimate, not less than one hundred elaborate scientific communications in various forms to different institutions and societies. His public lectures have been numerous, a collection of which, with other pieces, have been published with the title *Lay Sermons, Addresses and Reviews*. In a lecture "On the Educational Value of Natural History," delivered at St. Martin's Hall in 1854, occurs the following pas-

sage:—"There is yet another way in w
I am convinced, take a profound hold n natural history may,
that is by its influence over the finer fe on practical life, and
all sources of that pleasure which is deriv rs, as the greatest of
not pretend that natural history knowledge from beauty. I do
our sense of the beautiful in natural objects. . such can increase
son uninstructed in natural history, his country . But to a per-
is a walk through a gallery filled with wonderfu sea-side stroll
nine-tenths of which have their faces turned to the orks of art,
him something of natural history, and you place in h ll. Teach
catalogue of those which are worth turning round. Su hands a
innocent pleasures are not so abundant in this life, that y, our
afford to despise them, or any source of them." an

The lectures "On the Vertebrate Cranium," 1864, are distinguished by the lucid manner in which one of the most complex subjects in the whole range of inquiry is treated. Professor Huxley differs from the high authority of Professor Owen as to the nature of the skull; he depreciates all ethnological systems on which the shape of the skull is erected into the principal standard by which the affinities are to be judged. The characteristics on which he relies are complexion, hair, and eyes; guided by these he divides mankind into four great types, viz., Australoid, Negroid, Mongoloid, and Xanthocroid or Blond.

An able critic, speaking of Professor Huxley's lectures from the Hunterian chair, which he so ably fills, says:—"Never before in England have all the leading and most significant facts of animal structure been so exhibited; never have all the most complex and intricate questions of zoology been treated with such clearness and completeness—such boldness and yet with such caution—such patient, original investigation, and yet with so much scrupulous justice to the labours of others. It is impossible to speak too highly of the admirable lucidity with which Mr. Huxley enunciates facts and the conclusions he deduces from them, or, on the other hand, of the exemplary caution with which facts are verified and weighed, and a prudent suspension of judgment recommended where many would be tempted to pronounce a definite decision. When, however, the facts seem to him to warrant an absolute judgment, or to point to a strong probability, the announcement is made accordingly with a conscientious boldness deserving of all praise."

Professor Huxley's share in discovering the origin of glaciers of slaty cleavage was in this wise: Professor Tyndall having brought forward certain views as to the origin of slaty cleavage, Mr. Huxley drew his attention to observations made by the late Principal J. D. Forbes; and it was supposed by Huxley slaty cleavage might be owing to a like cause. Out of this grew the expedition of Messrs. Tyndall and Huxley to Switzerland, and their inspection of the glaciers of Grindenwald, the Aar, and the Rhone. In this expedition commenced the investigations which are thought by many to have refuted the viscous theory of glacier motion propounded. Forbes, maintaining that the motion of glaciers is the result of the minute, almost molecular fracture and regelation of the ice-particles, which move as if they were sand continually thawing and re-freezing.

Professor Huxley's palæontological investigations are very various, and are embodied in numerous scattered papers communicated to the Royal Geological and other kindred Societies. Professor Huxley professes himself an evolutionist. Evolutionism, as the geological creed of the future, he predicts is destined to take the place alike of catastrophism and uniformitarianism.

With respect to the relation in which Professor Huxley conceives scientific inquiries stand to Christianity, some of his opinions have been much questioned, both by scientific and other writers. In particular, certain statements or modes of expression which seemed to savour of materialism in a lecture *On the Physical Basis of Life,* delivered in Edinburgh in November, 1868, and afterwards published in the pages of the *Fortnightly Review,* have afforded ground for adverse comment. In that paper he has, however, expressly said, "I, individually, am no materialist, but, on the contrary, believe materialism to involve grave philosophical error."

And, in his *Lectures to Working Men,* Professor Huxley says, "All our knowledge and all our investigation cannot take us beyond the limits set by the finite and restricted characters of our faculties, or destroy the endless unknown, which accompanies, like its shadow, the endless precession of phenomena."

Amongst the contributions of Professor Huxley to lectureship during the past year should be noticed his "Instruction in Science and Art for Women," in twelve lectures on Physiography, delivered by Mr. Huxley, at South Kensington. The Syllabus of each of these lectures is, to use a popular comparison, as entertaining as a fairy tale. Thus, in the introductory statement, we are pleasantly told :—

A Map of the Thames is an outline sketch of the river, as it would present itself to a person passing over it in a balloon.

The Thames at London Bridge is a mass of fresh water one-sixth of a mile wide. In its deepest parts it is sometimes as little as twelve, and sometimes as much as thirty, feet deep.

The water of the Thames at London Bridge runs down (ebbs) towards Margate for about seven hours, and then runs up (flows) towards Teddington Weir for about five hours, twice in every day.—The river is shallowest at the end of the ebb, deepest at the end of the flood tide.

About 115,000,000 cubic feet more water runs down, than runs up, beneath London Bridge every day.—The over-plus goes beyond Margate into the sea.

Above Teddington Weir the water always runs down towards London Bridge.—A continuous stream of fresh water, running in this general direction, can be followed as far as Thames Head in Wiltshire, which is 170 miles from London Bridge and 370 feet above the water of the Thames at that bridge.

The water which ebbs and flows under London Bridge all comes from the Basin of the Thames, the area of which is 6,000 square miles.

The Thames carries down to the sea not less than 14,000,000 cubic feet of solid material, either dissolved or as mud, every year.—At the present rate of denundation the whole basin would be washed down to the sea level in 1,000,000 years; and the surface of Britain would everywhere be washed down to a plain, level with the sea, in less than 5,000,000 years.

Professor Huxley is one of the members of the recently-appointed Royal Commission on scientific instruction and the advancement of science; and he now holds the post of President of the Ethnological Society. Professor Huxley has, it is stated, accepted the office of Professor of the Birmingham and Midland Institute, held in 1869 by Mr. Charles Dickens.

The accompanying portrait of Professor Huxley is from a photograph by Messrs. Elliott and Fry, of Baker Street.

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THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

THE WORKMEN'S INTERNATIONAL EXHIBITION, ISLINGTON.

THIS interesting and important "Festival of Labour," opened in the Agricultural Hall in July last, was in some respects an advance upon its predecessors; but altogether less perfect in the objects exhibited and the principle carried out. There were only six French exhibitors, and the representation of other nations was by no means complete. Italy, Denmark, the Netherlands, and India, all sent large and valuable contributions. Wurtemberg, Bavaria, Austria, the United States, and Spain had each a very few articles; and consignments were received from Peru and from Rio Grande. The classes were 16 in number, and were:—I., inventions; II., objects for workshop competitions; III., machinery; IV., objects of decorative art; V., furniture; VI., ornamental metal-work; VII., glass and china; VIII., building appliances; IX., fancy work; X., articles for personal and domestic use; XI., cutlery and arms; XII., scientific apparatus; XIII., watches; XIV., saddlery and miscellaneous leather work; XV., textile fabrics; and XVI., food, raw materials, and miscellaneous articles. Besides all these, there was a so-called Fine Art Department, consisting partly of a loan collection, and partly of the works of individual exhibitors.

The general arrangement was as nearly as possible this:—Inventions, machinery, and machinery in motion were placed on the ground floor under the north gallery. Next to them were arranged cutlery and arms, then furniture, then ornamental metal-work, then china and glass, then building appliances, scientific appliances, and personal and domestic requisites.

In the class of machinery the number of exhibitors was very much larger, and a far higher standard of excellence has been attained. It would be impossible to mention a twentieth part of the things that deserve mention on their merits. A machine for making screwed boots, made by W. H. Steel, is simply fed with brass wire, and it cuts the end of the wire into a screw, drives it into the sole to the required depth, and then cuts it off level with the surface of the leather. The operation is extremely ingenious, and the specimens of work exhibited are highly creditable. B. W. Maughan, of Goswell Street, exhibited a patent invention for heating water speedily. It consists of an arrangement of coils of wire heated by gas flames. Water admitted at the upper part of the apparatus trickles over the wire and runs out hot below with such speed that a gallon can be raised nearly to the boiling point in a minute. Mr. Stevens, of Coventry, exhibited a Jacquard riband loom at work; had eight tiers of shuttles, and it weaves portraits, landscapes, mottoes, heraldic and other devices, with great finish and correctness. James Milbourne, of Birdcage-walk, Hackney-road, had a series of machines for boot and shoe-making, in which the leather is cut out by stamps, compressed between rollers (instead of being hammered), and finally is rivetted together with a great saving of time and labour. The Locomotive Department of the Midland Railway Company sent a very interesting collection of parts of an engine in various stages of manufacture. A working model of a circular railway and a long carriage on bogie platforms were very attractive. The railway is about 4 ft. in diameter, and a portion, or loop, of a different curve projects from the main line on one side, and is connected with it by switches. These switches are opened and shut by systems of levers, which are set in action by bars that can be pushed down at pleasure from the carriage or engine. The exhibitor adjusts the bars, and then gives the carriage a smart push. On its bogies it runs round the line with facility, and it opens for itself whichever road, the inner curve or the outer loop, it has been previously set to act upon. The idea is that the engine-driver might always be his own pointsman.

The interests of locomotion were represented in many modes as well as by objects pertaining to railways. Bicycles and tricycles abounded, and some of them were of very light construction and distinguished by various improved arrangements. There was a little pony-trap with a third wheel behind. Remarkable only for convenience of arrangement and excellence of finish, there was a Danish tramway omnibus, bearing a general resemblance to those of American manufacture, which are now running between Bow and Whitechapel, but produced at too high a price for the English market.

Besides actual machinery there were many models of considerable interest. Perhaps, the best in the Exhibition was a working model of a vertical steam-engine, by Joseph Bruce, a brass-dresser, of Haydon-street, Birmingham.

In Decorative Art Class the most conspicuous objects were the specimens of wood carving, and the painted imitations of various woods and marbles. There was a good deal of wood carving, but the majority of the English examples were wanting in finish and perfection of workmanship. Messrs. Blews and Sons, of Birmingham, exhibited specimens of ecclesiastical carving that were excellent both in design and workmanship, and some of the best of them had been executed by a woman, Mrs. Dewson. There were some very fine specimens of Italian workmanship, chiefly in the way of picture frames. The painted imitations of various woods and marbles were of really extraordinary excellence. Around the panels were some specimens of wall decoration by a workman named Pearce, who is deaf and dumb, but who is certainly an artist of considerable merit. Here may be mentioned Miss Allen's wax models of flax, cotton, and other plants, which are of finished execution and true to nature. Gibson, of Belfast, and Jacques, of Dublin, both exhibited a pretty collection of carved ornaments in Irish bog oak. Messrs. Salviati contributed a mosaic picture in Venetian enamel, "Our Lord on the Judgment Throne," after a cartoon by Mr. Gambier Parry. George Coates, and three others, of Scarborough, had sent a collection of jet ornaments, elaborately carved and of great beauty, but at prices ranging from 15*l.* to 30*l.* the set.

"Attention (says the *Builder*) must be called to one feature in this Exhibition, which was its especial boast. Among English localities, Birmingham and Sheffield are first in the field—the former with a beautiful case of electro-plate, the latter with knives, dirks, scissors, and other articles. In these cases are fixed printed cards, on which are detailed the several processes which are resorted to before each object is complete—designing, modelling, casting, embossing, engraving, and so on; and to each of these is affixed the name of the workman actually engaged. Each artificer, it may be said, signs his own work. The true spirit of industrial art is thus brought into direct opposition to the mere greed of trade. The maker comes into the field to assert his identity, which the seller is but too content to smother. It is the application of the co-operative system to industry. Nor do we doubt that in the application of the principle lies the best hope of our future industrial welfare.

"One of the most important features of the Exhibition was a table covered with scraps of iron. There was a plate some half-inch or three-quarter inch thick, doubled in four, like a sheet of note-paper. By its side was a small bar, drawn out into an endless corkscrew at one end, and hammered into a sort of knife at the other. The worm was twisted while hot, the blade was hammered when cold. Every specimen displayed unusual malleability or ductility in this ordinarily stubborn material. Two or three lumps of coarse grey metal—being neither more nor less than fragments of the famous 'Seely's pigs' (or, as they ought rather to be called, the *Builder's* pigs, since we first drew attention to their wasteful use in the pathways at Portsmouth)—lie close by. By the application of a chemical agent in the puddling-furnace, the coarse, poor metal has been converted into that of fine-grained texture. Knowing what we do of the race which Russia is about, sooner or later, to run with this country in the manufacture of iron, we direct especial attention to this discovery of Sir Antonio Brady. Of great interest, too, is the collection of copies (models and drawings) sent by the Industrial School of Amsterdam, established to aid technical education.

"The King of Italy sent a couple of ironclads to convey his workmen, and to do honour to the working man's fair. The

King of Denmark did the same. The King of Wurtemburg followed the example."

Nor must we omit to notice a reflecting telescope, of 10 ft. focus, and 13 in. diameter of reflector, made entirely, and that within eighteen months, by a baker, of Nottingham—Mr. Bush, who had the satisfaction of explaining his workmanship to the Queen. *Mr. Bush has made two reflectors, one of which is of the usual speculum metal, ground by himself (which is in the instrument, and which is remarkable for the purity and intensity of the light which it reflects)*, and one of glass, also parabolically ground, on which it is intended to deposit a surface of silver. The telescope is in what is called a cradle frame, bolted together with longitudinal wrought-iron bolts, passing through wrought-iron distance tubes and circular distance pieces. The segment which attaches the trunnion, or axis of movement, resembles the cylinder of a locomotive. The instrument is equatorially mounted, and is to be moved by clockwork. A prism of Munich glass catches the object reflected, and refracts it to the eyepiece. The division of the brass arch is also the handiwork of Mr. Bush, who has made his own lathes, grinding apparatus, and dividing apparatus.

Another noteworthy object was a noble ebony cabinet, inlaid with Florentine mosaic, encrusted with *lapis lazuli*, and ornamented with statuettes and reliefs in silver gilt, which was sent from Florence. Italy, indeed, has come to the fore in this Exhibition.

Nor was it Florence alone that sent her marbles, and alabaster, and mosaic. Naples sent her characteristic work in coral and in lava; Rome her shell cameos—those nearest imitations of the precious onyx reliefs of the ancients; Sorrento sent the well-known marquetry and perforated woodwork of the brothers Gargiullo; Genoa sent her silver and gold filagrees; Venice her opal and avanturine, and ruby-tinted glass. The marble of Carrara was represented in numerous statues,—a bust of King Victor Emmanuel at the head of the trophy; and several other sculptures.

Upon the general results of the exhibition the *Builder* has these judicious remarks:—

"The degree of success which has attended the opening of a Workmen's International Exhibition at Islington has not been such as to lead to the confirmation of the opinion that the leaders of the working classes are yet in a position to take the reins of power. Of that Exhibition we speak in all sympathy and kindness. Its object, so far as it had a distinct and avowed object, was good. Men remarkable for influential position, or estimable for noble qualities, spared neither time nor trouble to ensure success. Shrewd, sensible, practical men, worthy representatives of the industrial classes, laboured as honorary secretaries and committeemen. The Queen paid a pre-opening visit, at the cost of not being able to open in person the most ornamental public work of her reign. The heir to the Throne opened the Exhibition officially. The Prime Minister postponed a cabinet council to make a speech at its close. With all that the Exhibition was a failure. It was so in a financial sense, as the final accounts produced at the close showed a deficit of some 1,500*l.*; but even more than this, it was a failure in an industrial sense. It failed to induce the body of men for whose benefit it was designed to come forward to support it. *Containing, as it did, some good native productions, of which the country might well be proud, it relied almost entirely for its attractive power upon foreign contributors,—Italy, Denmark, India, and Austria. Subtract the products of these countries, and there was but little to repay a visit to the Agricultural Hall.*"

THE ALEXANDRA PALACE AND PARK.

At length has been completed the Alexandra Palace—the reconstructed building of the International Exhibition of 1862, but improved both externally and internally, equably warmed and ventilated, and admitted to be one of the best conductors of sound in existence—a feature of great importance in an edifice covering an area of about nine acres, is, amongst numerous other attractions, designed for musical performances upon a large scale. The Park consists of about 400 statute acres of nobly-timbered woodland and grassland, delightfully situated upon a healthful, picturesque, and commanding elevation, about five miles north of St. Paul's Cathedral, and will be easily accessible by rail from all parts of the metropolis; indeed, from almost every point embraced in the railway network of Great Britain. The Palace being finished, even to the decorations, and the Park presenting a tasteful specimen of landscape-gardening, it is proposed to purchase the property by means of a Tontine and Art Union Association, and to convert both Palace and Park into an intellectual and healthful resort for the enjoyment of the people.

PATENTS AND PATENTEES (MELBOURNE).

We have been favoured by Mr. W. H. Archer, Registrar-General of Victoria, with three quarto volumes, Lists of Patents and Patentees, based upon the plan adopted by the British Commissioners of Patents. They comprise lists of patents granted or applied, from 1854 to 1866, and indexed for 1868; they are classified and arranged, the claim of the patentee or the peculiarity of the invention being briefly given; also a list of patentees, the titles and dates of their inventions, and of terms and phrases used in the titles. We need scarcely add that this work must prove of great utility to inventors, capitalists, practical manufacturers, and others. Abstracts of the patents are given, with explanatory plates of certain inventions; and the arrangement of the work, as well as the printing, are very satisfactory throughout.

Accompanying the above are "Abstracts of English and Colonial Patent Specifications Relating to the Preservation of Food," compiled from the documents in the Patent Office at Melbourne, and derived from the large collections of specifications in the United Kingdom, New South Wales, and Victoria. The pamphlet scarcely extends to 90 pages, which, however, are most economically filled with details and references to other sources. The preservatives of food are by cooking, by ventilation, air, ice, evaporation and freezing mixtures; drying by hot air; extraction from meat; various modes of salting; exclusion of air; antiseptic agents; substitutes for salt, spices, &c. The utility of such a collection of information is self-recommendatory, especially as the economy of food is now so extensively before the public.

THE MITRAILLEUSE.

THE history of this "new invention" in "the mystery of murder" is curious. First, going back to Grose's *Military Antiquities*, 1801, we are told that in England, in the year 1625, under Charles I., a patent for a new invention was granted to a certain William Drummond. The invention is described as a machine composed of a number of muskets joined together, by the help of which two soldiers can oppose a hundred, and named, on account of its effect, "thunder carriage," or, more usually, "fire carriage."

In the *Mechanics' Magazine*, it is stated, "The idea of grouping gun barrels was exemplified by the Chinese very many years ago. We can call to mind seeing a Chinese Mitrailleuse, if we may so term it, at the Dublin International Exhibition of 1851. It merely consisted of a series of, we believe, six musket barrels, secured side by side in a frame with the touch-holes turned upwards, and over these a little trough was arranged to contain a train of gunpowder. The entire affair was very rude in workmanship and design: it had nothing but the old slow-match lock. It appeared that the inventor intended that two men should carry it, it having a handle behind, which gave the whole apparatus the appearance of a gridiron. There was a bar of iron made to pivot on the barrels near their muzzles, so as to form a leg or rest, on which it was evidently intended one man should steady it while it was being discharged by his comrade.

Next—Mr. S. A. Goddard, writing to the *Birmingham Daily Post*, says: "The description given in the papers of the French arm, the 'mitrailleuse,' corresponds in the essential respects with that of the rifle battery, invented by me in the year 1853, and completed, as a breech-loader, in the year 1855–6, being, however, apparently more complicated in construction, and less effective in action. I earnestly entreated the minister-at-war, and also Lord Palmerston, to permit an inspection of this arm at Woolwich; but without effect. It was objected that it would not be more effective than the howitzer throwing shrapnell, and would require a distinct army organisation. I replied that it would throw bullets twice as far as the howitzer, required no separate organisation, but could be used as an auxiliary to artillery, which is the way the French propose to use the 'mitrailleuse,' and would require less than one-third the number of men to work it; but the application was still refused. In 1856 the French Government obtained a full description of the battery. In 1857 it was taken to Washington, and tried on the Potomac, with perfect success with respect to the principle, to test which was the only object; but a portion of the forging proving defective, it was placed in the Arsenal, where it has since remained, subject to the inspection of visitors; and, in the year 1863, an American in London obtained a description of it and got up a similar arm, which may be the same that Government has now under consideration. My invention, by which the battery could discharge 720 bullets in a minute, each as effectively as an Enfield rifle, antedates all the others now spoken of by the papers by ten years or more."

In 1868 the French military authorities tried some experiments with a weapon the invention of a M. de Montigny, of Belgium. This arm closely resembles the mitrailleuse at present in use in the French army. It merely consists of a set of musket barrels to the number of thirty-seven, arranged in a frame and made on the breech-loading principle. Behind these there is a species of box, into which a series of blocks can be successively placed. These blocks have chambers to contain cartridges, which are either successively or simultaneously discharged at will by means of percussion caps at the rear of the blocks.

The weapon at present so highly prized by the French is an improvement on this. It will be seen from the *Mechanics' Magazine* (published October 8, 1869) to resemble alike both the Chinese gun and the Belgian weapon already described, consisting, as it does, of a cluster of gun barrels made on the breech-loading principle, but unlike the Belgian weapon in that the block at the breech is not entirely separate from the rest of the piece, but resembles a common breech-loading gun in having the breech-block attached permanently by the pivot pin on which it is moved when reloading the gun. The actual gun as at present in service on the Continent has been somewhat improved, we believe, by the introduction of separate cartridge blocks, whereby the efficiency of the arm is enhanced, inasmuch as a party of gunners can be at work reloading their blocks while their comrades are discharging the gun at the enemy.

THE FRENCH AND BELGIUM MITRAILLEUSE.

THE following brief description is equally applicable to both arms:—The machine gun consists of a cluster of barrels, either bound together or bored out of the solid, and mounted on the same principle as an ordinary field gun. At a few hundred yards, indeed, it would be difficult to distinguish between these weapons, as far as outward appearance goes. To the barrel is attached a massive breech action, capable of being opened and closed by a lever. In the Montigny arm the cartridges are carried in steel plates perforated with holes corresponding in number and position to the holes in the barrel. This steel plate, in fact, forms the "vent piece" of the system. The central fire cartridges being dropped into the holes in the steel plate, stand out at right angles from it, and the plates, thus ready charged, are so carried in limber and axletree boxes specially fitted for their reception. When the gun comes into action the breech is drawn back, a steel plate full of cartridges is dropped into its corresponding slot, and the breech block thrust forward and secured. The gun is now on full cock, and contains from 30 to 40 cartridges, which are fired by a "barrel organ" handle, either one by one as the handle works round click-click, or in a volley by a rapid turn of the wrist. When the gun is empty the breech block is again withdrawn: the steel plate, carrying the empty cartridge cases, lifted out, and a fresh plate dropped in, if necessary. The advantage possessed by the machine gun over infantry fire is that it is never in a funk. Bullets may rain around, bursting shells may fill the air, still the 37 barrels of the mitrailleuse shoot like one man, and at 800 or 1,000 yards will pour volley after volley of deadly concentrated fire into a circle of from 10 to 12 ft. in diameter. No boring or fixing of fuses is required, and the whole operation is performed so rapidly that two steady cool men could maintain a fire of ten discharges per minute. On the other hand, the mitrailleuse could not well compete with the field gun, and it is with this weapon it will assuredly be met. Its bullets would have comparatively slight effect at the ranges at which field artillery projectiles are perhaps most effective, while its size would offer a very fair mark to the gunner. It will be remembered that experiments were made at Brussels about two years ago, when, we believe, the following results were obtained:—The mitrailleur then used had 37 barrels, and in one minute's firing the results obtained exceeded those of four 6-pounder field guns which fired 12 rounds. In 10 rounds, 5 at intervals of half a minute, and 5 in 40 seconds, out of 330 cartridges exploded, 278 bullets hit the target (measuring 10 ft. to 12 ft.) at 437 yards, and with only one man serving. At 650 yards, 58 per cent. of the total number of bullets struck; and at 866 yards, 33 per cent. The machine worked perfectly, although it had been exposed to several hours' rain, and, we believe, a charge of from 400 to 500 grains was used safely. This gun is essentially the same as the Gatling, an American invention, used towards the close of the war. It has 10 barrels of 1 in. calibre, and throws iron balls of half-a-pound weight. It fires 250 rounds per minute with great accuracy, at from 2,000 to 2,500 yards.

THE AMERICAN GATLING MITRAILLEUSE

Is an entirely new system of fire-arms. The inventor is an American, says the *American Engineer*, and extensive and perfect machinery at Colt's Armoury has been put in operation, where the improved guns are made in great perfection, and so constructed that every part will be interchangeable—an advantage of infinite value, as in service any casualty can be at once remedied, and the effectiveness of the battery preserved by supplying new pieces for any which may have become unserviceable. To give the reader an idea of the character of this gun, it may be said that it can be fired, when well manned, from 400 to 500 times per minute. Its main features may be briefly summed up as follows:—First, it has as many locks as there are barrels, and all the locks revolve with the barrels. The locks also have, when the gun is in operation, a reciprocating motion. The forward motion of the locks places the cartridges in the rear ends of the barrels, and closes the breech at the time of each discharge, while the return movement extracts the cartridge shells after they have been fired. When the ten-barrel gun is being fired, there are five cartridges at all times in the process of loading and firing, and at the same time, five of the shells, after they have been fired, are in different stages of being extracted. These several operations are continuous when the gun is in operation. In other words, as long as the gun is supplied with cartridges (which is done by means of "feed-cases," in which they are transported) the several operations of loading, firing, and extracting the cartridge shells are carried on automatically, uniformly, and continuously. The locks operate on a line with the axes and barrels, and are not attached to any part of the gun, but as the gun is made to revolve, they play back and forth in the cavities in which they work, like a weaver's shuttle, performing their functions of loading and firing by their impingement on stationary inclined planes or spiral projecting surfaces. Second, it can be loaded or fired only when the barrels are in motion, that is to say, when the barrels, the inner breech, &c., are being revolved. Third, it may justly be termed a compound machine gun; since the ten barrels, each being furnished with its own loading and firing apparatus. form, as it were, ten guns in one. This is a valuable feature, for in the event of one of the locks or barrels becoming impaired, the remaining ones can still be used effectively. A few men furnished with these death-dealing engines will be able to defeat thousands armed with ordinary weapons. It may safely be said, that no other gun, which can be rapidly fired, has so great a range and accuracy as the larger-sized Gatling guns, which have an effective range of 2,000 to 3,000 yards.

In the *Times*, September 8, 1870, are the following details picked up to illustrate the action of the mitrailleuse in war:—The most detailed account of the direct action of mitrailleuses was given by the correspondent of a contemporary who was present at the battle of Gravelotte. The French were in position behind breastworks on a hill, their artillery was planted some distance in rear. The mitrailleuses appear to have been in line with the foremost works. The Prussians prepared their attack by a cannonade with 120 guns, and, after half-an-hour's firing, the 33rd Prussian regiment "dashed up the hill." "When they got half way up, the mitrailleuses opened upon them and did terrible execution at close quarters. The men, however, pressed on, though they fell literally by hundreds." They struggled on, and actually succeeded in forcing an entrance into the works. But the mitrailleuses were not taken. Their lightness enabled them to be run back quickly some 400 yards, and then opened a tremendous fire from them and the guns which had never been brought forward. The Prussians, in their advance, had pushed a half-battery half-way up the hill, but the mitrailleuses fired so quickly and so well that the 33rd were driven out of their hardly-won trenches, the mitrailleuses followed their retreat, and inflicted terrible losses on them. The half-battery tried to reply, but was overpowered, and unable to retreat because all its horses were killed. Then the Prussians, according to their system of sacrificing masses of men to gain their purpose, sent cavalry at the hill to take it. In vain—"men and horses rolled over in the hollow road, and they were in turn compelled to retire." A cloud of skirmishers was next sent forward from the 67th regiment of the line. The men, well taught, "crept from bush to bush, and from rock to rock, taking advantage of the slightest inequality of the ground to shelter themselves." A "tremendous" fire of artillery supported their advance, and once more columns of troops were driven up the road at the position. The brave soldiers got into the works, but the French fire was so terrible that they had to retire again. At half-past five the Prussians seem to have run short of ammunition, for they desisted from the attack, and more cartridges and artillery were brought up. A farmhouse, La Villette, had been made into a strong position by the French, and commanded the hollow road, so a heavy fire of Prussian guns was brought to bear on it till their ammunition also was exhausted, and at half-past six their fire almost ceased. The quarter of an hour was spent in refilling the empty boxes, and once more the cannonade began. La Villette caught fire, but the French still held the garden. "At 7.20 the final attack began. The 72nd regiment charged at the slope, followed soon afterwards by a regiment of Hussars. After more than an hour's fighting in the dark, the French began to retire, *the mitrailleuses protecting their retreat*." The letter of our Berlin correspondent shows that the carnage in this action had been frightful. In some cases nearly half the attacking regiments had been killed or wounded.—*Mechanics' Magazine*.

It was either on this day or the day after that an event occurred, narrated in a letter from a Prussian officer in these words:—

"The first regiment of Dragoon Guards went first into fire, and were so slaughtered that only 120 men were left; the 2nd Dragoons were taken up to make up the number of the 1st, and were in their turn cut down. The very flower of the Prussian nobility has perished. Our friends and familiar faces that we met every year in society are all dead, and there is the saddest desolation."

A Vienna paper explains that this slaughter had been caused by a line of mitrailleuses masked by infantry until the approach of the Dragoons, when the foot soldiers retired and the deadly work began. It appears from the letters of our Berlin correspondent that the broken cavalry were charged by French horse and almost annihilated. "In one regiment of the Guards 42 officers are killed or wounded."

But we have forgotten the first battle before Metz, when the French were attacked before crossing the river. The *Vœu National*, a Metz paper, speaks of an artillery fire which created great havoc in the Prussian ranks, and says that two batteries of *mitrailleuses planted in the orchards of the farm of Bellecroix swept away whole ranks at each discharge.*

The following careful, comparative views are by Mr. Bourne, in the *Illustrated London News*:—

"The progress of the war reveals a great dearth of scientific resource in the implements of destruction employed. The French have, no doubt, got the mitrailleuse, which, so far as we have been able to judge from the accounts which have reached us of its performance, has done good service to its possessors. But the Prussians appear to be without any new military resource, and their successes are wholly due to the ancient military excellences of good organisation, courage, and numbers. There is no doubt that the successes of the Prussians would have been greater and their losses less if they had been provided with such improved military weapons as science could have placed within their reach. But here, as elsewhere, Prussia has suffered from her illiberal and dishonest policy towards inventors, since men of talent will not take the trouble of maturing inventions from which they are not to derive substantial advantage. The principle of the mitrailleuse is sufficiently obvious, and has often been proposed; but, until introduced into the French army, it never obtained a trial in actual war. Then there is the Gatling gun, already described, which promises to be equally effective. We are of opinion, however, that both of these implements are only provisional, and that a simpler and more effective contrivance for discharging a stream of balls will hereafter be brought forward. In the way of long-range rifles nothing has been attempted, yet it is clear that weapons which would enable the enemy to be effectively assailed while the assailant was still out of range would give an important advantage to the party possessing them. The means of obtaining a long-range weapon is plain. It consists in the combination of a rocket with a bullet in the same cartridge, by which means the propelling force both of the gun and rocket will be obtained; and optical expedients should be introduced to enable a correct aim to be taken at a long distance. Torpedoes and floating rockets have been very inadequately utilised in maritime warfare; and if Prussia had possessed a fraternity of competent inventors, means could have been found to sink the French fleet without the necessity of bringing another fleet against it at all. From such resources, however, Prussia, by her illiberal policy, has cut herself off, so that her successes are obtained at a greater sacrifice of life and wealth than would otherwise be necessary; while France, though not indisposed to introduce improvements, does so on too small a scale, and then expects them to accomplish miracles which they were never competent to perform."

To conclude, the mitrailleuse, in its functions, therefore, in the battle-field, is clearly between those of Horse Artillery and the old Dragoons—foot soldiers carried on horses, who have been so often longed for, but whose place is now more than supplied. For ditch defence in fortresses, and for the defence of villages, farm-yards, &c., the mitrailleur is acknowledged on all hands to be a most admirable invention.

USE OF BALLOONS IN TIME OF WAR.

M. W. De Fonvielle, editor of the *Liberté*, has addressed to *The Times* a letter in which he describes his employment of what he calls a trade balloon, "the largest in existence, and the best for the war service," in the mighty struggle between the French and Prussians. He writes, November 26, 1870:—"The Prussians of late had taken many balloons, owing to the utter inexperience of the aeronauts, or the bad construction of aerial shipping; and, taking advantage of these failures, Prussian spies had circulated among our Parisian papers *that no more ascents would be made in the daytime*, that henceforth aeronauts would ascend after sunset and before sunrise. Aeronauts are so far from being understood by our learned men that several balloons were sent in so ridiculous a manner. I did protest in the *Liberté*, a paper with which I am connected, and declared that I could pass the Prussian lines in open day, without fearing anything from their ridiculous shooting. Consequently I ascended last Thursday, November 24, at 20 minutes to 11, before many thousands of people, and crossed the whole of Paris at a height of about 1,800 yards, when I saw that my balloon was on the Prussian *avant-poste*. I ordered a couple of sandbags to be thrown out, and I reached in safety the level of 2,500 yards, when Prussian music was heard in a most impotent manner. These fools below, being deceived by the diameter of my balloon, believed I was near them, and were using their powder to no purpose. The firing continued up to the vicinity of Soissons, but showed intervals of recrudescence, very likely when we were passing over Prussian encampments. I carefully noted these places on the maps, for giving information to military authorities, taking advantage of Prussian firing range. Firing did not prevent the balloon continuing its way, and ascending to 3,500 yards, when firing ceased. Railway trains were seen running; social life was restored; it was not necessary to go further. Prussians had not set their feet in these quarters. But a true aeronaut is always disappointed when obliged to put an end to an ascent; the spectacle is so magnificent over clouds. I resolved to land only in Belgium, and I did, as was reported by telegram. Wind was very strong, as we travelled 240 kilometres (180 miles) in about three hours and a half. The descent was not dangerous, as I had chosen a large plain, but rather long, and almost all of us were slightly hurt—one of the passengers in the head, and another in the back, my lieutenant in the foot, and myself in the hand, &c. Nothing of the kind would have happened if the balloon had been completed, but I was so anxious to put in execution the aerial plan that I ascended without my rope being in order. I was aware that I was incurring some risks, but I was certain that there was no real danger, and, at all events, I was resolved not to stay a single day longer, Lieutenant Bunel having been sent with due instructions for repairing the balloon, and preparing different apparatus for warlike purposes." In the Franco-Prussian war, 1870, Mr. Glaisher first suggested the balloon-pigeon combination, of which we read so often.

FRENCH FIELD ARTILLERY.

A DOCUMENT has come into the possession of the *Times*, which, it is maintained, indirectly throws considerable light upon the present condition of the Field Artillery of the French army. It will be remembered that Sir Joseph Whitworth sent to the last Paris Exhibition two specimens of his steel field-pieces, the one a 10-pounder and the other a 3-pounder. These guns, having attracted the notice of the Emperor, were sent by his desire in the first instance to Versailles, and afterwards to the camp at Châlons, for exhaustive experiment, under the direction of the Commission permanente d'Expériences, and it is their report which we have now before us, dated so recently as last year. It is a most valuable document as a record of the performance of English field guns in the French camp; but its chief interest at the present moment lies in the undoubted evidence which it affords of the great inferiority of the field guns, made of bronze, with which the French artillery is equipped in the war with Prussia, at least as compared with English steel guns.

This evidence is supplied by a series of tables near the end of the report, in which the performances of these latter guns are compared with those of the "*canon de quatre de campagne,*" as regards range, lowness of trajectory, retention of velocity at long distances, and accuracy. In all these particulars the French bronze gun was much inferior to both of the steel guns, and in some respects is so inferior as to bear no reasonable comparison with them. Even at 5 degrees of elevation, the range of the 3-pounder exceeds that of the French 10-pounder by 290 metres, while the English 10-pounder exceeds the other by 440 metres. But as the range increases the inferiority of the French becomes much more marked. Thus, at 10 degrees, the French gun ranges 2,350 metres, the English 3-pounder 3,120, and the English 10-pounder 3,320. At 20 degrees the ranges are 3,480, 5,000, and 5,490 metres respectively; and at 30 degrees, while the range of the French gun is but 4,100 metres, the English 3-pounder has a range of 6,100, and the 10-pounder 6,890 metres. These inferior ranges of the French gun are associated, as they must be, with correspondingly high flights or trajectories, rendering the aim of the artilleryman very uncertain in the field, where distances have to be judged hastily and by the eye alone. In ranging 2,000 metres the French shell rose to a height of 83 metres, while the highest point of the trajectory of the 3-pounder was 54 metres, and of the 10-pounder only 51 metres. At 3,000 yards' range the *maximum* ordinate of the trajectory of the last-named gun was 130 metres, that of the 3-pounder 137, and that of the French gun 253 metres! Those who understand the relation between a low trajectory and good aim in the field will discern the immense disadvantage of the French gun in this comparison. Not less remarkable is its want of *conservation de la vitesse*, or the quality of keeping up the power to hit hard throughout its flight. The initial velocities of the projectiles of all three guns were nearly alike, varying between 331 and 361 metres per second; but after travelling 1,000 yards the velocity of the French projectile fell to 247 metres, that of the steel 3-pounder being still 302, and that of the 10-pounder 311 metres. At 2,000 yards the velocities were 194, 276, and 282 metres; and at 3,000 yards 166, 252, and 264 metres. As the penetrating effect of a shell depends upon its velocity, it is easy to see how inferior the French arm must be in this respect likewise. Its inferior accuracy is also very remarkable, especially at long ranges; but we have not space to record all the figures. Those already given are taken without alteration from the official Report. It is only necessary to add, that bronze is of less than half the strength of good steel, or of Whitworth metal, and that much of the inferiority of the French gun is attributable to its use, it being quite impossible to fire the full charges of powder and length of projectile from a bronze gun of given bore without speedily destroying it.

THE FORTIFICATIONS OF PARIS IN 1870.

PARIS is divided into two portions by the Seine, which runs obliquely from south-east to north-west, as far as the boundary line of the old city, near the Place de la Concorde. The district lying to the north of the Seine is the larger and lower of the two; that to the south of the river is considerably higher. The whole may be taken as an irregular circle, of which the Seine is the oblique diameter. The northern portion is the more important and exposed. It is bordered by the Seine on the south-west, and the second line of the same river, as it reaches towards the north-east from Sèvres to St. Denis, covers it on the north-west. On the east is the Marne, and on the north the range of hills which commences on the east near the Marne and stretches irregularly around the northern semicircle as far as the Bois de Boulogne. On the north-east is the plateau of Belleville, which, according to Captain Lendy—whose admirable edition of *Lavallée* is almost the only reliable source of information in respect to the military geography of the theatre of war—lies 460 ft. high, and extends from 984 ft. to 4,920 ft. in breadth. This plateau forms an embankment extending irregularly from the hill of Chaumont, which is 377 ft. high, towards the south to Charonne, and towards the east to Bagnolet, with Romainville on the north and the Prés St. Gervais on the north-east. To the north of the Butte Chaumont lies the Rue d'Allemagne, which leads out to the road to Metz. Along the north side of this route runs the Canal de l'Ourcq, which helps to protect the district. On the north side of Paris, north of the Seine, is the hill of Montmartre, which rises 426 ft. high, is 318 ft. broad, and forms a commanding eminence close on the boundary line of the city, inaccessible on all sides except that towards the town. It is a position of surpassing strength, and, if well defended with artillery, would be almost impregnable. Montmartre is separated from Belleville by the plain of St. Denis. These three positions—the plateau of Belleville, the hill of Montmartre, and the plain of St. Denis—are the natural defences of Paris, and must be the objects of particular attention in any serious attempt to lay siege to the capital.

The system of Fortifications constructed for the protection of Paris since 1840 comprises an *enceinte* 35,914 yds. in length, completely enclosing the city upon all sides, bastioned and terraced with 30 ft. of wall. The wall on the right bank of the Seine is 25,722 ft. long, and runs around the exterior of the communes of Bercy, Charonne, Belleville, La Villette, La Chapelle, Montmartre, Batignolles, Les Ternes, Passy, Auteuil, and Point du Jour. That portion of the *enceinte* to the left of the Seine is 10,192 yds. in length, and passes around Grenelle, Vangirard, Petit Montrouge, and Petit Gentilly. On the exterior of the *enceinte* are the casemated works and independent forts, of which most lie on the right bank of the Seine. On the north is

St. Denis, with a double crown-work facing the north, north-east, and north-west; a special fort on the east, and the little fort of La Briche on the west, together forming a strong defence for the city on the north (No. 1). To the south-east of St. Denis lies the redoubt of Aubervilliers (No. 2), covering La Villette on the north-east. Further to the south is the fort of Romainville (No. 3), and on the same line, still further to the east, the fort and earthwork of Noisy (No. 4). Proceeding south are two forts (Nos. 5 and 6), covering Bagnolet and Montreuil on the north-east. Further south Rosny (No. 7), and still more to the south and east the fort of Nogent (No. 8), within which lies the great fortress of Vincennes. At St. Maur and at other points north of the Seine are redoubts, but those named are the most considerable. To the south of the Seine are the forts of Charenton, between the Seine and the Marne; Ivry (No. 9), Bicêtre (No. 10), Montrouge (No. 11), Vanves (No. 12), Issy (No. 13), and (No. 14) the great fortress of Mont Valérien, which towers above everything in the neighbourhood on the west of Paris, and commands the westerly reach of the Seine and the Bois de Boulogne.—*Globe.*

THE FRANCO-PRUSSIAN WAR—TYPOGRAPHY.

A CORRESPONDENT of *Notes and Queries* draws attention to the fact that the battle-field of the above campaign attained early celebrity as the head-quarters of Typography. Metz was one of the first towns which practised the art of printing, and the ancient works which came from its press are very numerous. Strasbourg is asserted to have been for some years the home of John Gutenburg, although no dated book is extant of an earlier year than 1471. Toul is to be noted as the place at which one of the first attempts at stereotyping was made. The Sedan editions compete with the Elzevirs in the estimation of book collectors, and are beautiful examples of minute typography. Kehl was the ultimate resting-place of Baskerville's type, with which M. Beaumarchais printed an edition of Voltaire's works on blue paper for King Frederick of Prussia, "who laboured under weakness of the eyes." At Rheims and Verdun printing was carried on at an early date, and the latter place has a special interest as having been the place where the English prisoners who were detained by Napoleon I. printed, with his permission, an edition of the English Book of Common Prayer. There seems to be some little doubt whether we derived our sedan chairs directly from the place of that name; for Evelyn asserts that they were brought from Italy by Sir Sanders Duncombe, and the word may perhaps be related to the Italian *sedente.* This point is as knotty as that connected with the kindred word coach, on which volumes have been written, supporting the rival claims of Kottsee, a Hungarian town, and the French *coucher.*

THE SEDAN SHELL.

Mr. W. Hope has read to the British Association a paper which stood in the journal against his name, under the title of "The History of the Shell that Won the Battle of Sedan." He said that on account of the pressure of business under which the section was working, he would not read his paper, but would content himself with giving a short account of it. Its original title had been somewhat different from that under which it now appeared, and was "on some of the obscurer forms of *Filum incarnatum officiale* (or official red-tape) occurring in the upper gubernacular strata of the British Isles; illustrated by the history of the shell that won the battle of Sedan." He then went on to say that during the siege of Sebastopol he was in charge of a battery that commanded some of the approaches to the Malakoff, and that fired spherical shrapnell shell. It was his practice to watch for the passage of Russian troops in order to fire at them, and also to watch the effect that his fire produced. The spherical shells rolled over and over in their flight, and he observed that when the bursting charge happened to be in front of the shell towards the enemy, the bullets were dispersed backwards, and did little or no harm. When the bursting charge was in the rear of the shell, the bullets were thrown forward among the enemy, and produced a much greater effect. He was hence led to contrive an elongated shell, in which the bursting charge should be always in the rear of the bullets, and which, in fact, resembled a gun itself. The construction of this shell was explained by the aid of a sectional drawing, and Mr. Hope went on to say that he submitted his invention, in 1856, to the Chairman of the Ordnance Committee, who told him that as it required a rifled gun it could not even be taken into consideration, because rifled guns would never be introduced into the British service. He next tried Colonel Boxer, and succeeded better with him; in so far that Colonel Boxer retained his shell and promised to consider it. After a time, Colonel Boxer took out a patent for a shell that was in all essentials the same, and Mr. Hope was about to state the steps that he had taken in consequence, when he was stopped by the President, who explained to him that he was entering upon subjects which it would be contrary to the rules, and foreign to the objects, of the Section to entertain or discuss.

in flatness of trajectory, and in hard hitting, the Prussian field-piece is by far the more powerful weapon. Much of this is due to the calibre. The French *canon rayé de* 4 is a bronze muzzle-loader converted into a rifled gun by grooving the old 6-pounder smooth-bore, the calibre of which is 3·4 in. The calibre of the Prussian steel 4-pounder is, however, only 3·1 in.; its projectile, consequently, although of the same weight, is of less sectional area than that of the French gun. The Prussian shells are, therefore, better adapted to overcome the resistance which the air opposes to all bodies moving through it, and the result is that they lose less of their original velocity, and, consequently, hit harder at a distance. It is easy to prove that the atmosphere offers resistance to bodies passing through it, and that the amount of this resistance depends in a great measure on the velocity or rate at which the body may be moving. If we take a book, open it, and, having placed one page upright, pass it forward, the page will shut by the resistance of the air. In walking in the open air on a clear calm day we experience very little resistance from the atmosphere; a canter on horseback, however, produces a refreshing current, and we feel a breeze, as it were, against the face; while on the same day, if we put our head out of a railway carriage, we are obliged to press down our hat firmly to prevent its being blown off. To all appearance, however, there is no wind. We can understand, therefore, the enormous resistance which a shot must experience, travelling as it does ten times as fast as the fastest train. This resistance, moreover, is considerably influenced by the shape of a shot. As the bluff collier stems the current with difficulty as compared to the taper yacht, so the dumpy, ill-proportioned projectile meets with a greater resistance than one formed on more scientific principles.—*Globe.*

A NEW PROJECTILE.

CAPTAIN ERICSSON announces, in a communication to the American *Army and Navy Journal*, that he has perfected the system of submarine attack, by which he can destroy the largest iron-clads ever built. The resistance of the water is so great that explosive Projectiles have always proved failures hitherto when designed to strike below the water-line. Captain Ericsson is confident that he has devised a projectile which will overcome the difficulty caused by this resistance. It is an elongated shell, charged with 300 lb. of dynamite, and shot from a 15-in. gun at such an elevation as to enter the water near the hostile vessel, and strike the hull anywhere below the water-line. It is fitted with a percussion cap, which explodes upon very slight impact against the hull, so that the velocity of the shell when it reaches its destination need not be high. The gun is carried on a swift armoured boat, protected by a turret. Captain Ericsson intends to make a formal offer to test this invention. He is ready to fit out at his own cost and risk a fast screw vessel with two 15-in.

guns of the kind described, if somebody else will furnish the iron-clad to be experimented upon. In the politest terms he does this country the honour to single out the new British ironclad, *Devastation* as one of the most splendid specimens of an armoured war vessel which can be produced, and challenges her to come out and encounter his torpedo.—*Pall-mall Gazette.*

MOVING HEAVY GUNS.

EXPERIMENTS have been made at the Royal Military Repository, Woolwich, of a new method of Moving very Heavy Guns, invented by Lieutenant Alexander B. Brown, Royal Artillery. It seemed to be an adaptation of Brown's patent method of transporting heavy weights from one locality to another by means of a portable tramway and friction balls, on which a slide or carriage bearing the weight rests, thus being quite independent of the nature of the ground over which the weight has to be conveyed, and doing away, to a great extent, with the many prejudicial resistances which now stand in the way of, and render so difficult, the transport of our heavy ordnance. The surprising ease with which this great weight, some 12½ tons, was made to rotate on its centre by means of a pivot, without any inclination to overturn, by only four men, without any other mechanical appliances, struck all present as an important feature in combination with the tramways for changing direction, going round raised curves, or turning sharp corners. To move the weight from one place to another in the Repository grounds required less than half a quarter of the number of men usually employed on such an operation, when no tackle, &c., are employed, while the speed with which so heavy a mass of metal was moved was equally notable. When near the end of its journey it was caused to turn another corner by a very ingenious arrangement, which dispenses with the use of the pivot at first employed, a curved tramway being used instead, while the platform turned on three balls on its own roadway, thus doing away with the necessity of raising the entire weight off the roadway into the pivot, and lowering it again after changing direction. The project is most simple, yet notwithstanding its simplicity, it is far more effective than the means at present adopted. The gun weighed 12½ tons, and the platform 1½ ton, making a total weight of 14 tons, which passed up and down inclines with the greatest ease, a detachment of about ten men alone being required to remove the gun experimented upon. These men were entirely unacquainted with the invention, having been taken from other duties for that purpose. The tramway or iron gutters over which the gun passed were merely placed on the ground without any previous preparation, and after the gun had passed over a portion of them, they were taken up and relaid in front, thus forming a continuous tramway for any distance. The size of the shot is not material, but about 10-in. is the best. —*Mechanics' Magazine.*

THIRTY-FIVE-TON GUNS.

THE operation of welding together the two largest and most important sections of the 35-ton Gun has been successfully performed at the Royal Gun Factories, in the presence of numerous officers and scientific men from various parts of the country. As the gun will be the most powerful ever manufactured, so this operation was the most gigantic of its kind ever performed. The 35-ton gun is a monster weapon called into existence by the contest known as the battle of guns and armour, a rivalry which it is expected to determine by throwing a 700 lb. shot through a 15-in. iron plate of wrought iron. It is not thought that any serviceable ship can be built to carry a thicker armour than this. The gun is being constructed on the Frazer principle, and will be a muzzle loader. It is to be built up of five concentric rings, each of which is made as strong as skill and experience can make it. First, there is the inner tube—the gun proper—of toughened steel, called the A tube; then the B tube or chase of coiled iron, which is placed over the A tube to strengthen the breech end; next the B coil and the breech piece, and finally over all, the trunnion hoop—these successive layers being massed upon the breech, where endurance and elasticity are most required. It was the welding together of the two last named that constituted the operation under notice. At half-past eleven, fifty smiths, under the direction of Mr. Price, manned a huge pair of tongs, 40 ft. long and 15 tons in weight, and dragged forth from the furnace the massive "heat," weighing in its present form nearly 28 tons. This was carried by the aid of machinery under the adjacent 10-ton Nasmyth hammer, and forged with marvellous facility, the two sections, which had been merely shrunk together before entering the furnace, being, after an hour's work, thoroughly incorporated in one. The red-hot mass was then left to cool, which will take two or three days, and it will then be put into a lathe and trimmed up to shape. Its extreme diameter was nearly 5 ft. When complete, the calibre of the bore will be 11½ in., and the length of the gun 16 ft. It will probably be rifled with 9 grooves, each 1½ in. wide, and 2-10 in. deep, with a twist of rifling increasing from zero at the breech to one turn in forty calibres at the muzzle. The position of the vent has yet to be determined, and will depend upon the result of the experiments now being made by the committee on gunpowder. The weight of the projectile, as before stated, will be 700 lb., its length of solid shot will be 2 ft. 6 in., and if common shell about 3 ft. 4 in. The charge used will be 120 lb. of powder. A portion of the company, under escort of Colonel Campbell, superintendent of the Royal Gun Factories, afterwards proceeded to the new forge and witnessed the coiling of a tube for a 9-pounder gun. The iron bar having been heated in a furnace nearly 200 ft. long, was drawn out and curled round a drum by a very simple process. It was stated that the iron bars forming the breech-piece of the 35-ton gun were 6 in. in diameter and 400 ft. long.—*Mechanics' Magazine.*

THE MARTINI-HENRY RIFLE.

THE first course of experimental firing and testing of the Martini-Henry Rifle over the army shooting ranges at Browndown, near Gosport, has been concluded, and in the general results is very favourable to the new arm as compared with the Snider. The trajectory is lower with the new arm than with the Snider, and, with a strong wind blowing across the range, the shooting is incomparably the straighter. The sword bayonet fitted to the Martini-Henry is also considered to be a much superior weapon to the old bayonet, as well as being more available for general uses with troops in the field. The length of the Martini-Henry rifle also enables the two front ranks to fire standing, a most important consideration in the opinion of many military men, now that infantry are armed with breechloaders whose rapidity of fire is being every day increased. The defects in the new rifle and its equipments appear to be a smallness of the chamber as compared with the size of the cartridge used, a weakness in the spring which causes missfires, and an utter unsuitability for service in the field of the partitioned ammunition pouch. The first defect may easily be remedied by either making the chamber of the rifle larger or the diameter of the cartridge less than at present. Now the slightest bend in the cartridge, even of so small a nature as to be invisible to the eye, renders loading impossible. A slight alteration in the power of the spring will cure the fault of missfires, and the partitioned ammunition pouch will simply have to be discarded for one that can be more readily filled and used in the field.

THE WHITWORTH GUN IN FRANCE.

A DOCUMENT has come into our hands which indirectly throws considerable light upon the present condition of the field artillery of the French army. It will be remembered that Sir Joseph Whitworth sent to the last Paris Exhibition two specimens of his steel field pieces, the one a 10-pounder and the other a 3-pounder. These Guns, having attracted the notice of the Emperor, were sent by his desire in the first instance to Versailles, and afterwards to the Camp at Chalons, for exhaustive experiment, under the direction of the Commission permanente d'Expériences, and it is their report which we have now before us, dated so recently as last year. It is a most valuable document as a record of the performance of English field guns in the French camp, but its chief interest at the present moment lies in the undoubted evidence which it affords of the great inferiority of the field guns, made of bronze, with which the French artillery is equipped in the war with Prussia, at least as compared with English steel guns. This evidence is supplied by a series of tables near the end of the report, in which the performances of these latter guns are compared with those of the "*canon de quatre de campagne*," as regards range, lowness of trajectory, retention of velocity at long distances, and accuracy. In all these particulars the French bronze gun was much inferior to both of the steel guns, and in some respects is so inferior as to bear no reasonable comparison with them. Even at 5 deg. of elevation the range of the 3-pounder exceeds that of the French 10-pounder by 290 mètres, while the English 10-pounder exceeds the other by 440 mètres. But as the range increases the inferiority of the French becomes much more *marked. Thus, at 10 deg. the French gun ranges 2,350 mètres. the English 3-pounder 3,120, and the English 10-pounder 3,320. At 20 deg. the ranges are 3,480, 5.000, and 5,490 mètres respectively; and at 30 deg., while the range of the French gun is but* 4,100 mètres, the English 3-pounder has a range of 6,100, and the 10-pounder 6,890 mètres. These inferior ranges of the French gun are associated, as they must be, with correspondingly high flights or trajectories, rendering the aim of the artilleryman very uncertain in the field, where distances have to be judged hastily and by the eye alone. In ranging 2,000 mètres the French shell rose to a height of 83 mètres, while the highest point of the trajectory of the 3-pounder was 54 mètres, and of the 10-pounder only 51 mètres. At 3,000 yards' range the *maximum* ordinate of the trajectory of the last-named gun was 130 mètres, that of the 3-pounder 137, and that of the French gun 253 mètres! Those who understand the relation between a low trajectory and good aim in the field will discern the immense disadvantage of the French gun in this comparison. Not less remarkable is its want of *conservation de la vitesse*, or the quality of keeping up the power to hit hard throughout its flight. The initial velocities of the projectiles of all three guns were nearly alike, varying between 331 and 361 mètres per second; but after travelling 1,000 yards the velocity of the French projectile fell to 247 mètres, that of the steel 3-pounder being still 302, and that of the 10-poundor 311 mètres. At 2,000 yards the velocities were 194, 276, and 282 mètres; and at 3,000 yards 166, 252, and 264 mètres. As the penetrating effect of a shell depends upon its velocity, it is easy to see how inferior the French arm must be in this respect likewise. Its inferior accuracy is also very remarkable, especially at long ranges. but we have not space to record all the figures. Those already given are taken without alteration from the official report. It is only necessary to add that bronze is of less than half the strength of good steel, or of Whitworth metal, and that much of the inferiority of the French gun is attributable to its use, it being quite impossible to fire the full charges of powder and length of projectile from a bronze gun of given bore without speedily destroying it.—*Times.*

THE PRUSSIAN NEEDLE-GUN.

THE alteration of the Prussian Needle-Gun has been sanctioned by the King, in consequence of which the two or three millions of rifles in the possession of this Government were to be remodelled.

The improvements introduced aim at simplifying the loading, and increasing the force and range of the ball. For this purpose the caoutchouc ring of the Chassepot has been adopted, which, helping to close the breech by spontaneous action, renders it unnecessary to press the valve down so tightly. In addition to this, the weight of the ball has been reduced from 31 to 21 grammes, which, with the charge remaining at 4·9 grammes, as formerly, considerably augments the propelling force. To fit the reduced ball for the old barrel, the *zund-spiegel* has been proportionately enlarged, a proceeding the practicability of which was proved by a similar alteration adopted some time ago, and further attested by a year's experiments with the weapon in its present latest form. On the needle-gun being first taken into favour in 1841 it had a ball of 15·43 millimètres, but the heaviness and consequent want of speed observable in the missile caused it to be soon reduced to 13·6 millimètres, which size has now been further diminished to 12 millimètres. The total weight of the new cartridge is 32 grammes, instead of 40 grammes, as heretofore, so that the soldier will henceforth carry 95 instead of 75 cartridges, without experiencing an additional burden. Besides this, the needle is now made to move in a narrow hole, into which it fits exactly, instead of the wider one of the old gun, and a piece of oiled paper is placed at the bottom of the cartridge to clean the needle after each discharge, and serve some other purposes of minor importance. By these improvements it is hoped to raise the Prussian needle-gun, which has the glory of being the first breech-loading rifle ever introduced into an army, to the latest requirements, and make it practically a match for all its manifold rivals. Though among these latter there are some with a ball of only 11 and even 10 millimètres, it is contended that the advantage derived from this small calibre is of no practical use in the field, and that the Prussian rifle, in its present form, fires quite as rapidly and as far as the purposes of warfare require. That the alterations resolved upon are not very costly is owing to the ingenious construction of the *zund-spiegel*, which admits of a small ball being shot out of a comparatively wide barrel.—*Mechanics' Magazine.*

PARIS DEFENDED WITHOUT GUNPOWDER.

In time of war invention is at rest, or is concentrated upon improving means of destruction. It might have been anticipated that the French Academy would have been inundated with suggestions of means for destroying life; but such has not been the case, and the first novelty we have seen in the way of engines of destruction is that suggested by M. Delaurier, at the last meeting. It is really nothing more than the Lenoir gas engine, adapted to the discharge of projectiles. A mixture of gas and air is exploded in a sort of cannon, and away goes the ball—to what distance and with what velocity is at present rather a matter of guess than calculation or experiment. Seven volumes of gas to 100 of air ought, we are told, to produce the greatest effect; but the machine to use the mixture is not yet in existence. It ought, says M. Delaurier, to be of iron, and to be shaped like a retort (the ordinary glass retort), the belly of which is to hold the mixed gas and air, and the tube, which must be long, is to form the barrel. As the ball must hermetically seal the barrel, it should, we are told, have a wadding of lead. As the new engine will not foul, and will give no smoke, it may be used continuously, and there will be no difficulty in pointing it. How far it might, if it existed, be useful in the defence of Paris, is made clear by the following statement. Paris consumes 400,000 cubic mètres of gas per day. This quantity of gas may be made to throw more than a million of 60lb. shot—how far is not stated; nor is it said how Paris is to be lighted during the time. Another suggestion by M. Delaurier is to store a mixture of gas and air in cellars, and in houses carefully sealed, to be exploded at the proper time (which everybody can guess) with terrible effect.—*Mechanics' Magazine.*

SUBMARINE WARFARE.

IN Sheerness harbour experiments have been made with a Torpedo, of a fish-shaped construction, of zinc, having a revolving "tail" at one end. It is necessary that a ship intending to discharge the torpedo should be fitted with an apparatus (also newly invented) for the purpose of compressing air within a sort of cylinder, and to this is fixed a long tube for the reception of the torpedo. This tube, which is similar to a rocket tube, is carried from the interior of the ship, through a hole in the bows, eight or ten feet below the surface of the water. The orifice of the tube next the water is covered with a cap, to which a line is attached and carried up to the forecastle for the purpose of removing it when all is ready to discharge the torpedo, the latter being filled with gun-cotton and other detonating and powerfully explosive substances. The cylinder being filled with air, the torpedo is placed in the tube in the same manner as a congreve rocket. The vessel is then steered to within a suitable distance of the vessel to be destroyed, and the cap removed by means of the line above mentioned. The compressed air is then forced into the tube, and the torpedo is launched with a sufficient submarine momentum to strike and destroy any ship within a range of from 100 to 1,800 yards. For the experiment, Her Majesty's steam sloop of war *Oberon* had been fitted with all the apparatus above described. She was steered (so as to avoid danger to other craft in the harbour) to within about 200 yards of *L'Aigle*, an old wooden frigate of great strength, and lately used as a coal hulk, which had been lent by the Admiralty for the purpose. This vessel was moored head and stern on the west shore of the Isle of Grain, in a sufficient depth of water to cause the effect of the explosion of the torpedo to be seen by the ship sinking some 10 or 12 ft., the object in view being that the destruction of the ship's bottom might be visible at low tide, and also that the vessel might be temporarily repaired so as to be floated for further probable experiments. The *Oberon* was placed bows on to *L'Aigle*, and a striped flag hoisted on board. Shortly afterwards this flag was lowered as a signal that the torpedo had been sent on its errand of destruction. It had been anticipated that the explosion would be instantaneous, but it was not so; and, after a few seconds had elapsed, whispers began to be heard that the experiment was a failure, or that the torpedo had taken a wrong direction. In about 30 seconds, however, from the lowering of the flag, an explosion occurred, under the counter of *L'Aigle*, and a mountain of water, blackened with coal-dust from the refuse in the hulk, thrown up. The stern of the ship rose bodily with it, and now was heard a report resembling the dull boom of a heavy piece of ordnance heard at the distance of a mile or so. *L'Aigle*, immediately on falling back into the water, sank by the stern until she took the bottom, but had there been sufficient depth of water she would have totally disappeared. As it was, the ship speedily filled with water from stem to stern, and in about a minute from the time of the explosion had sunk her entire length, and lay on the bottom, with only about 7 or 8 ft. of her upper works and bulwarks above the surface. It is believed the hole made in her counter and under her bilge must be of enormous dimensions, from her going down so quickly. The experiment was perfectly successful.—*Times*.

At Chatham the stationary electrical torpedoes and their appliances, as proposed by the Royal Engineers for adoption for the defence of our ports and harbours have been experimentally tested. A small torpedo was practised upon to show the action of the floating contact-maker, and a large one was fired to illustrate the practicability of exploding submarine torpedoes at will, and of testing the limits of proximity within which such weapons could be placed in respect to each other without the explosion of one damaging its neighbours. The practice proved that a distance of over 100 ft. was required to preserve adjacent torpedoes from damage by the exploded one. It was afterwards shown how torpedoes could be fired under ships by the intersection of two lines of sight taken by two observers, placed some distance apart. The experiments were most successful, the results demonstrating that a submarine torpedo can be fired at will, that it can be made harmless to a friendly vessel, and that it can be rendered fatal to an enemy.

SMALL IRON-CLAD SHIPS.

Mr. Michael Scott, C.E., has read to the British Association a paper upon a method of constructing ships of war of moderate dimensions. Mr. Scott's plan for a small ship of war is intended to compete with a "breastwork" monitor, as designed by Mr. E. J. Reed, C.B., late Chief Constructor of the Navy. The main object of Mr. Scott's plan is to reduce the amount of armour to the smallest possible extent, and so to dispose that which he must of necessity have as to protect the vital parts of the ship. Mr. Scott believes in a high freeboard as being essential for rendering a ship seaworthy, and he also believes that a high freeboard is not incompatible with the turret system. To quote Mr. Scott's words, he has "designed a structure, to wreck even the non-vital parts of which would occupy the most powerful modern war ships so long a time that before their task could be accomplished they themselves might be sent to the bottom." Now this is what we have always advocated. The power of a ship to withstand the attack which it is likely to meet does not consist in the aggregate weight of armour which it carries, but in the disposition of that armour. The small iron-clad which Mr. Scott proposes to build would be somewhat similar in construction to the *Enterprise* and *Research*, upon which Mr. Scott's plan is undoubtedly an improvement. He proposes to construct his vessel with a central fort with curved ends, both the sides and ends being armour-plated to a depth of about 6 ft. below the water line when the vessel is at fighting draught. This fort is intended to have an iron-plated shot-proof deck, and within its walls are the bases of the guns, ventilating, covering, and funnel turrets. There is to be no side armour before and abaft the central fort. Extending from the ends of the fort and covering the hull fore and aft, at a depth of about 6 ft. below the water line (fighting trim), there will be a shot-proof armoured deck; above this armoured deck, and rising with a sheer fore and aft, the hull of the ship is similar to that of an unarmoured vessel of war. About 6 ft. above the armoured deck (fore and aft the central fort) there is another deck of thin plate, the space between these two decks being divided into water-tight compartments, which would be in communication with the ship's pumps, and there would be wing spaces between these compartments and the top sides of the ship, which would afford facilities for stopping shot-holes or repairing damage sustained in action. Above these compartments (which Mr. Scott calls the deck tanks) and at a minimum height of 7 ft. is the upper or spar deck, and the space between this deck and the tank deck affords accommodation for officers and crew when the ship is out of action. It will be seen from what we have above stated that a ship built upon this principle would be comparatively light at the ends—a difficulty hitherto experienced in the construction of iron-clad ships. Another advantage which Mr. Scott's ship would possess over a "breastwork" monitor would be the larger area embraced within the central fort, thereby affording increased facilities for working the turrets and guns.

We now come to another important feature in this ship. For every day that a ship is in action she is years out of action, and therefore it becomes a question of great importance that the crew should have a ship which is fit for them to live in. It is, to say the least, not an unimportant matter that a ship should be properly lighted and ventilated, and rendered a fitting floating habitation for men. When fighting at close quarters, Mr. Scott's ship's draught of water would be increased by admitting water into the winged spaces and deck tanks, and also between the double bottom of the ship, if built upon the double bottom principle. It will be understood that if the deck of a "breastwork" monitor is penetrated, there is nothing to prevent the shot traversing the ship; but in Mr. Scott's ship the armoured ends of the fort are carried down to about 6 ft. below the water line, where they join the armoured deck fore and aft of the fort, whereby the passage of projectiles is prevented. From what we have briefly stated our readers will see the advantages which Mr. Scott believes he will gain by this system of construction.—*Mechanics' Magazine.*

PLUNGING FIRE.

An extremely satisfactory result, as far as the Navy are concerned, has been obtained at Shoeburyness. A target representing a portion of the deck of an iron-clad ship, protected by 1-in. iron plates, was fired at by the 9-in. muzzle-loading rifled gun, the projectile being Palliser shell, the charge the full battering one of 43 lb., and the distance 100 yards. The target was so arranged that the projectile struck at an angle of about eight degrees from the horizontal, so as to represent the angle of incidence of a shot fired direct at about 2,000 yards, or that of a projectile fired at 100 yards from a higher level; such, for instance, as that of the *Monarch's* battery as compared with the *Captain's.* It was found that at this angle the projectile did not enter the ship, but, after ploughing up the woodwork of the deck, ricochetted off it and went away screaming and whistling up into the air until lost from sight. One of the disadvantages urged against a low freeboard is thus disposed of as far as 9-in. guns are concerned. The *Monarch,* however, is armed with 12-in. guns, and it would be interesting to ascertain whether the above results would hold good in the case of the larger calibre. It seems desirable also to ascertain the actual angle at which a projectile fired horizontally will penetrate a ship's deck protected with as much iron as is admissible in its construction. Ships' decks may often be subjected to a plunging fire from elevated batteries, such as those on Straddan Heights or Gibraltar. —*Globe.*

NAVAL ARCHITECTURE.—STREAM LINES.

A paper on "Stream Lines," by Professor Rankine, has been read before the Royal Society, which may be regarded as an extension of the investigations on stream lines made by Professor Stokes in 1842 and 1850, and by Dr. Hoppe in 1856. By a stream line is meant the line described by a particle in a running fluid, and the investigation of the nature of these lines is held to be important, chiefly as illustrating the proper form of the water lines of ships. The theory of the resistance of ships has of late years been revolutionised, and the first steps in this direction, Professor Rankine says, were taken by Mr. Bourne, who ascribed the main part of the resistance not to the necessity of displacing the water but to friction, and who consequently maintained that the immersed perimeter was a more accurate measure of the resistance than the sectional area, which had up to this time been adopted. Mr. Bourne also showed that the water lines of a ship should be of such a configuration that each particle of water which was encountered by the stem would be moved sideways in the manner of a pendulum until it reached the middle of the vessel, when it would flow inward again by the return beat, and come to resist at the stern. But he further showed that vessels built upon this principle did not sail much faster than ordinary vessels, whence he deduced the conclusion that the main resistance is that of friction, which doctrine is now that which is generally accepted. Professor Rankine says that it has been discovered by Mr. Froude that at high speeds a form of vessel with round, blunted ends, like the neck of a swimming bird, is better than a very sharp bow, which will no doubt be true, if the area of each successive cross section is the same in both cases, as the rate of displacement will be the same, and the surface, and consequently the friction, will be the least in the blunted, semicircular vessel, formed with swan-like lines or cygnoids, as Mr. Froude proposes to call them. But in this discovery there is no addition to our previous knowledge of the subject, as it was long since shown to be a consequence of the amended doctrine of resistance which has now been adopted.—*Illustrated London News.*

SCREW ARMOUR-CLAD RAM.

THERE has been launched from the Govan shipbuilding-yard of Messrs. Robert Napier and Son, Glasgow, a Screw Armour-clad Ram, built for the British Government, and named the *Hotspur*. The dimensions are as follows:—Length between the perpendiculars. 235 ft.; breadth, 50 ft.; depth in hold, 20 ft. 1 in.; burden, 2,637 18-94 tons builder's measurement; and 600-horse power. This war ship is constructed on a principle that is entirely new in this country, but which was adopted some time ago in connection with the Navy of France. Its chief features are the formation of a fixed tower or turret, the breastwork of which is 8 in. thick, and an immense ram forward. The diameter of the turret, which is pear-shaped, is 31 ft. 6 in., and 35 ft. 9 in. from the aft to the fore side. This stationary turret is armed with a 30-ton gun, carrying 600 lb. of shot. It is worked on a revolving turn-table, the diameter of which is 26 ft.; from the two front portholes the gun has a training of 69 deg., and at the side portholes a training of 4½ deg. aft, and 26 deg. forward, so that it is able to fire right forward, and almost, but not quite, right aft. The gun can be elevated 12½ deg. and depressed 7, the recoil being 6 ft. 3 in. The ram projects about 9 ft. below water, and is brought up to a sharp point at a depth of about 8 ft. below the water line. There are three decks, the middle one being plated with two thicknesses of iron tapered forward and aft. The engines, which have been made and fitted by the Messrs. Napier, are of the direct-acting horizontal description, having two piston-rods to each cylinder, and are fitted with surface-condensers and all the most recent improvements. The boilers, of which there are four, are of the ordinary tubular type, with five furnaces each. The propellers are 14 ft. in diameter, on Griffiths' plan, with movable blades.—*Mechanics' Magazine.*

IRON SHIP-BUILDING.

MR. C. H. PALMER has read to the Iron and Steel Institute a paper "On Iron as a Material for Ship-building, and its Influence on the Commerce and Armament of Nations." This treatise was divided into two portions—first, the advantages of iron as a material for building ships; and, second, the gradual development of the use of that metal in the construction of vessels and its influence on commerce and armaments. The value of land for agricultural purposes had tended to diminish very greatly the growing of timber for ship-building, and foreign nations were unable to supply in sufficient quantities and at a reasonable price good wood for the purpose. Dr. Fairbairn, in a work on iron ship-building, had pointed out the superior advantages which wrought iron possessed over all other materials for ship-building. The iron plates of a vessel could be so rivetted together that the joints would sustain a breaking strain equal in double rivetted joints to 70 per cent., and in single rivetted joints to 56 per cent. of the breaking strain of the solid plate; and this after taking into account part of the plate punched or drilled out in making the joint. It was also set forth as the result of, and deduction from, experiments that if the skin of a vessel could be made of wood six inches thick without joints, it would be equal to iron plating rivetted together of 1¼ in. in thickness. This proportion was established on a comparison of the tensile strengths of the two materials; but so far superior were the facilities for uniting different pieces of iron to those of combining wood, that the 1¼ plating would be 134 times stronger than the wood sheathing combined in the ordinary manner used in wood ship-building. It was so difficult to fasten the wooden skin of a vessel, that the combination was only 1-134th part of the tensile strength of the material. Iron ships weighed 35 per cent. less than the timber vessel, while the displacement of water was the same. Greater strength was attainable, higher sailing qualities secured, and the strain less in iron-built ships. The number of voyages made by iron screw colliers to and from London had risen from 17 in 1852 to 2,440 in 1869, while the tonnage carried in the same period had risen from 9,483 to 1,716,563. Taking the tonnage of British vessels built, he found that there were in 1850 wooden vessels carrying 120,895 tons and iron vessels carrying 12,800 tons. In 1868 the proportion was reversed. In that year the tonnage of timber-built vessels was 161,742, and iron-built vessels reached 208,101. The same marvellous increase of iron vessels over wooden was also seen in the amount of steamers constructed. In 1850 the gross tonnage of wood steam-vessels was 217,829, while that of iron was only 57,361; but in 1868 the tonnage of wood vessels was only 122,282, while that of iron vessels had risen to 1,341,106. America had not advanced in iron ship-building, because labour was dear and the manufacture of iron was a costly process. France had made no perceptible progress in adapting her mercantile marine to modern requirements. In England they had among the vessels composing the British navy vessels of 130,150 tonnage, and 9.400 tonnage of a composite character. Ship-building in Holland was altogether on the decline. The Norway ship-building was entirely confined to timber vessels, while as for Italy its commerce was mostly carried on by English steamers. He was of opinion that the position already attained by England would enable her to keep a foremost place in commerce for many years to come.—*Times*.

LOSS OF THE TURRET SHIP "CAPTAIN."

THE loss, during September, of the turret-ship *Captain*, which was capsized in the Bay of Biscay by a squall, has brought to a melancholy close the persistent agitation maintained by Captain Coles during many years to press into use this class of vessel. We have always been conscious of the faults of Captain Coles's system, which, in any eligible feature, was an imitation of the monitor system of Ericsson, but with special defects from which the American vessels have always been free. But in many minds the disaster to the *Captain* will be imputed to the use of turrets; and a high freeboard, as it is called, or a considerable height of side above the water, will be regarded as quite indispensable to safety. Now, the first condition in the design of a ship of any kind is that it shall swim; and the next, if an armour-plated vessel, is that the armour shall keep the shot out. In the monitors the necessary stability is obtained by constructing them without masts, or with very low and light masts if sails should in any case be introduced. But, as a general rule, the monitors are steamers pure and simple, and, though many of them have been at sea in rough weather, none of them have ever been overturned. The stability of any vessel of known configuration and immersion, and with any given dimensions of rigging, is a matter of simple scientific calculation. But in the construction of the *Captain* many blunders were committed—one of which was that the draught of water was 2 ft. greater than was expected, and the height of side consequently 2 ft. less. Who was to blame for these errors Parliament will no doubt inquire. But Captain Coles never pretended to be a practical shipbuilder, and it is not to be supposed that the Admiralty would have consented to allow a large sum of money to be spent in the production of a vessel in which his leading idea of revolving turrets was to be embodied, except on the ground that the work would be carried out by competent builders, who would, at all events, see that the primary conditions of staunchness and stability were fulfilled. If the Admiralty had acted wisely it would have entrusted the design of a monitor vessel of the most formidable type to Ericsson, who has all the attainments necessary for the task, with the addition of the valuable experience gained in actual war. A high freeboard gives stability, or the power to resist upsetting; but it also gives unsteadiness, or a large amount of motion from the action of the waves. The needful stability can be obtained by discarding the masts and sails, which are not required, at least in the case of vessels intended to protect our coasts; and by keeping the freeboard low the thickness of the armour may be so much increased that it will be impenetrable. It appears to us that there should be only two classes of war-vessels—swift cruisers, without armour, carrying guns of very long range; and monitors propelled by steam alone, and with sides so low and thick that it will be difficult to strike and impossible to pierce them, and with guns heavy enough to send shot through any possible vessel having a high freeboard.—*Mr. Bourne, C.E., in the Illustrated London News.*

GREAT CIRCLE SAILING.

MR. J. T. TOWSON has read to the British Association a paper "On Windward Great Circle Sailing," illustrated by the Transatlantic yacht-race. Mr. Towson referred to the tables for facilitating great circle sailing constructed by him, and published by the Admiralty twenty-four years since, in which he pointed out the value of windward great circle sailing. The other modification of this sailing had been brought into successful use; but windward sailing, although it appeared most simple, had been generally misunderstood by practical men. Some had obtained charts having great circle routes laid down. If they were driven from this track by adverse winds, they returned as soon as the winds would permit them, not perceiving that, when they had quitted one great circle, there was another great circle, which was their nearest route. Others imagined that this sailing consisted in going a certain number of miles to the northward. The rule was simple: "Find the great circle course, and put the ship on that tack which is the nearest to the great circle course." In January last he was invited by Mr. Ashbury to prepare sailing directions for the *Cambria* yacht, which he did. These directions were shown by a chart. It consisted of the great circle course, corrected for variation, for every part of the Atlantic over which it was probable that a vessel should pass. All the mariner had to do was to ascertain his approximate position, and then he would find by inspection how to keep the ship's head by compass. The distance from the place of destination was also given by another chart containing the position of both yachts at noon for each day. Mr. Towson showed that the *Cambria* saved the race by superior navigation. This sailing gave the greatest advantage when the distance of longitude was greatest, and thus the *Cambria* attained all the advantage that this sailing could afford in the first five days, which was about 110 miles; afterwards the superior power for an ocean race possessed by the *Dauntless* prevailed, and reduced this advantage to a minimum.

THE BRITISH NAVY.

From an official return issued, under the authority of the Lords of the Admiralty, of the number, name, tonnage, armament, and horse-power of each vessel comprising the British Navy, it will be seen that there are 596 vessels of all descriptions, which may be classified as follows:—14 armour-plated iron screw ships; 9 armour-plated screw ships; 4 iron turret ships, armour-plated; 1 iron armour-plated ram, double-screw; 3 iron double-screw turret ships, armour-plated; 1 iron double-screw corvette, armour-plated; 1 double-screw armour-plated turret ship; 1 armour-plated turret ship; 2 iron screw corvettes, cased with wood; 11 iron screw troop ships; 4 armour-plated double-screw iron ships; 5 iron screw store ships; 2 armour-plated screw sloops; 2 armour-plated screw corvettes; 1 iron screw frigate, cased with wood; 1 iron double-screw gunboat, armour-plated; 1 iron and wood double-screw gunboat, armour-plated; 1 iron hydraulic gunboat, armour-plated; 2 iron double-screw tugs; 8 iron paddle vessels, 1 iron screw floating factory; 5 iron paddle tugs; 2 iron screw tank vessels; 1 screw iron tank and provision vessel; 4 iron screw floating batteries, armour-plated; 39 screw ships, 58 sailing ships, 30 screw sloops, 20 screw corvettes, 28 screw frigates, 15 screw gun vessels, 17 double-screw composite gun vessels, 2 screw block ships, 4 screw surveying vessels, 1 screw tank vessel, 1 screw store ship, 1 paddle store ship, 5 paddle yachts, 7 paddle sloops, 11 paddle vessels, 1 screw and paddle vessel, 11 double-screw gun vessels, 15 paddle tug vessels, 3 paddle despatch vessels, 1 paddle surveying vessel, 2 paddle frigates, 1 paddle distilling vessel, 56 screw steam gunboats, 113 harbour service ships, 25 coastguard cruisers, and 32 coastguard watch vessels. Of the foregoing, no less than 269 are in commission, and doing duty in various parts of the globe. In addition to the above, there are also 19 vessels now under construction, many of which are in a forward state.—*Mechanics' Magazine.*

NEW PROCESS OF METAL-CASTING.

At the Lancaster Engineering and Compression Casting Company's Works has been exhibited a new patent process of Casting Refractory Metals. This process is of American origin, and by it exact castings of plain, chased, or elaborately embossed work can be produced in brass, iron, bronze, &c., without any skilled labour, after the production of one pattern. Hitherto, the common loam moulds have only given out rough impressions, which for ornamented objects had to be laboriously finished by skilled workmen with delicate tools. By the new invention, the pattern is laid on an oiled foundation plate and besmeared with fine wet clay, after which it is buried in a box in mixed clay and sand, which is pressed downwards until it assumes the consistency of an unbaked brick. The clay cake is then carefully removed from the box, turned upside down upon a table, and the pattern lifted from the bottom by means of a small gutta-percha suction ball, leaving an impression in the vacuum. The mould, for such the cake then becomes, is hardened to a sufficient degree in a stove, and is then packed closely with others, for many can be used at once, in an airtight receptacle. The fused metal is then poured from the crucible into a channel opened into the vessel, and, aided by a pressing machine, forces itself into every crevice of the mould; the latter are afterwards taken out into the open air, and broken with hammers, and *fac similes* of the pattern used are found imbedded in them. The most minute lines are clearly produced, and it is said that medallion-working, type-casting, and file-making can be accomplished by the invention.

NEW FURNACE.

A NEW species of Blast Furnace has been proposed, in which the internal heat is more effectually maintained by the application of a flame jacket, through which the ignited gases, which would otherwise escape at the furnace-top, are conducted. As in steam cylinders, so in blast furnaces, there is no doubt that the internal heat will be increased, and the consumption of fuel lessened, by the use of jackets containing some fluid that is hotter than the external air; and the wonder is, that so obvious an improvement has not been long since adopted, seeing that the escape of heat through the furnace walls is known to be very great.—*Illustrated London News.*

CARBON AND SILICON IN IRON AND STEEL.

MR. G. J. SNELUS has read to the Iron and Steel Institute a paper on the "Condition of Carbon and Silicon in Iron and Steel," which gave rise to considerable discussion. The author stated that the object of the paper was to try and obtain some insight into the conditions under which carbon and silicon exist in iron. He had succeeded in separating by mechanical means large quantities of graphitic carbon from cast iron. The causes which led to high carbon in pig were alluded to, and it was stated that the carbon reaches its *maximum* when the blast is hottest, slag most basic, ores least siliceous and harden light. The author expressed his belief that there is no definite chemical compound of iron and carbon, but that the absorption of carbon by iron is a case of chemical solution, and he supported this statement by reference to the phenomenon of solution in general. The effect of silicon on iron or steel is to render it hard and brittle. Steel, which contains more than one-tenth per cent. of silicon, is brittle, though it is a rare thing for Bessemer steel to be faulty from this cause; it may sometimes occur, thus proving, along with the analysis of Bessemer metal taken during the blow, that in the Bessemer process the silicon is not removed before the carbon, as in the puddling and refinery processes, but along with it.

DANGER FROM UNION OF METALS.

MR. CLINKSKILL has exhibited to the Institution of Engineers in Scotland several pieces of boiler-plates cut out of destroyed boilers for supplying houses with hot water; the boilers were used with Loch Katrine water. The action on the plates was evidently due to a more active agent than ordinary corrosion, the surface of the plates being irregularly honeycombed to a considerable depth. In the case referred to the cistern was of lead, the boiler and connecting pipes of iron, thereby forming a galvanic battery, sufficient to account for the destruction of the plates. From the experience obtained, it appears advisable that in the construction of such hot-water apparatus, the cistern, boiler, and the connecting pipes should all be of iron, or, at least, of one kind of material.—*Builder.*

CAST IRON.

A NEW method of Casting Iron has been introduced in America. The moulds are made of clay, and the molten metal is forced into them by a piston under pressure, whereby the metal fills every crevice and interstice, and produces a far finer casting than would be obtained in the ordinary way. Nuts and bolts produced by this process are said to be as smooth and perfect as if finished by tools; and ornamental castings made on this principle are said to be finer than the celebrated Berlin castings. Certainly, the method of casting under pressure is the proper method of producing good castings, not merely in cast iron, but also in wrought iron and steel.

SHERMAN'S STEEL.

MR. J. E. SHERMAN, of the United States, has invented a new mode of purifying iron and making steel of common English iron. Mr. Sherman was invited to come to England by Her Majesty's Government, through Sir Edward Thornton, our ambassador at Washington. At the request of officers of the Admiralty, and, a part of the time, under the observation of a surveyor of the Admiralty, Mr. Sherman has been for some time engaged in making steel of common English iron at one of the leading steel works in Sheffield. The tool steel, steel ship-plates, and other qualities of steel made by him have been carefully tested at Chatham Dockyard, all of which have proved highly satisfactory. Some specimens of his steel are said to have borne a tensile strain of over 70 tons to the square inch, while, at the same time, they were more ductile than any other steel of the same tensile strength; and his steel ship-plates, in tensile strength and ductility, have been pronounced superior to anything of the kind heretofore known. Some experiments have been made at the Darlaston Steel and Iron Company's Works, and the results of these trials have been published. A low quality of common pig iron was worked in the puddling furnace in general use in the country. Some of the bars produced were cut up for melting into cast steel, in pot or crucible furnaces, and cast into steel ingots. These ingots, after having been tilted down to bars of 1 in. and 1½ in. square, produced a strong and solid quality of steel, equal to that made from Swedish iron. A piece of this steel, ½ in. square, was tested, and bore a tensile strain of 54 tons to the square inch, with an elongation of ⅝ in. in 6 in.—*Globe.*

IMPROVEMENTS IN IRON AND STEEL.

MR. HENRY BESSEMER has patented "Improvements in the Construction and Mode of Working Furnaces and Apparatus employed in Fusing Malleable or Wrought Iron and Steel, and Pig or other Carburets of Iron, and obtaining Cast Steel or Homogeneous Malleable Iron therefrom." The invention consists, first, in fusing malleable or wrought iron and steel, and also pig or other carburets of iron, in furnaces where the gaseous products of combustion within the said furnaces are retained under a pressure much greater than that of the external atmosphere, but which gaseous products are not greatly in excess of the pressure of the atmosphere which immediately surrounds the exterior of the furnace or some parts thereof, the difference being only such as will cause a powerful draught or current of air to pass through the fuel in such furnaces. For this purpose both the cupola and the reverberatory form of furnaces are employed, and these are constructed in the usual manner, except in so far as they require to be modified to suit the conditions under which they are employed in carrying out the invention. These furnaces are erected in the interior of an iron room or chamber, the iron casting extending beneath the floor of the room, having all its joints rendered sound and tight. These furnaces are provided with an outlet for the escape of the gaseous products of combustion exterior to the close chamber, the outlet being so *long as to prevent the free escape of the gaseous products of combustion, and retain the same within the furnace until the pressure is much in excess of the external atmosphere. The air to support combustion in these high-pressure furnaces is forced by a powerful blast engine into the close chamber in which the furnaces are erected. It is preferable to introduce it through* numerous small openings in a diffused state. The tapping holes or other discharge openings of these furnaces may be made to open externally to the close chamber, and in some cases the feeding doors may also be made to open outwardly or be accessible from the outside of the close chamber, or the tapping or discharge openings may open direct into the chamber and the cupola furnaces; the upper part may, in some cases, pass through the roof or crown of the close chamber, and be fed from an elevated feeding stage exterior to it, the mouth of the furnace being closed by a strong well-fitting door or cover to prevent the escape of gases.

Upon the expiry of Mr. Bessemer's patent in February last it was incidentally stated in the *Mining Journal*,—

"Mr. Bessemer is far too clever a man to allow 120,000*l*. a year, which he gets from royalties alone, to pass out of his hands. Recently he has invented a process by which the waste material that could not be converted into steel shall be converted. As this waste was about 30 per cent., it is manifest that he will be able to undersell all other makers, even though they use his first patent without paying for it. In other words, he will compel them to use his new patent—that is, to continue paying the royalty. Mr. Bessemer is now a man of enormous wealth, and the conservatory which he has just erected at his seat is probably the finest in the world. Yet it is little more than twenty years since he was a working engineer in North London, who, all his friends declared, would never do anything for himself, because he was always muddling away his time and his money in experiments."

Notwithstanding the scientific resources called into requisition by this branch of industry, few ideas have been propounded of which the original may not be found in the most ancient methods of manufacture. In Bessemer's original process for the production of steel, the carbon was only partially removed from the cast iron, a sufficiency being purposely left in combination to produce steel. But in practice it was found to be impossible to leave the exact quantity required; and so the whole was removed, and sufficient melted cast iron of known composition was added, to afford the necessary proportion of carbon. This, however, is only a reproduction of an old Indian process; and in many parts of India cast iron is manufactured for the sole purpose of producing steel by mixing it with molten wrought iron. In the Ellerhausen process—now being subjected to experiment at Dowlais—wrought iron is produced by mixing pulverised oxide of iron with cast iron. But the results, so far, have not been very satisfactory, although with pure oxide and pure cast iron there is nothing to prevent a successful issue. The method of producing wrought iron by mixing carbon with oxide and exposing the mixture to a high temperature in a cementing furnace is an old Indian method; and such iron may be melted by a neutral or reducing flame. In the common blowpipe the flame is either reducing, neutral, or oxydising, depending upon the part of the flame at which the trial is made; and furnaces are under similar regulation by the admission of more or less air.—*Illustrated London News.*

BOURNE'S NEW INVENTIONS.

Messrs. Bourne & Co. have brought out a number of new inventions, of which the most prominent are the following:—1. A new form of horizontal engine, of which the chief features are the superior quality of the workmanship and proportions introduced into engines of this class, and the balance of the momentum of the reciprocating parts, whereby high speeds become attainable without tremor. The working parts are of steel, as also is the cylinder, which is steam-jacketed. 2. A new species of governor, composed of an elastic sphere of brass, which changes its figure during rapid rotation, and this change of figure is made to act upon the throttle-valve and regulate the speed of the engine. 3. A new form of feed-water-heater, in which the jet of water expelled by the feed-pump is made to issue from an orifice with sufficient velocity to enter the boiler; but the naked jet, being surrounded by the waste steam of the engine, is heated to the boiling-point, and the boiler is thus fed with boiling water, while the apparatus required to raise its temperature is very small. 4. A band-knife for cutting timber, instead of a band-saw, whereby, under suitable arrangements, planks are cut from logs smooth at once, instead of being first sawn and then made smooth by planing, thus saving not merely much of the labour, but all the timber now wasted in sawdust and shavings. 5. A tobacco-cutting machine, whereby tobacco and other fibrous substances are cut into very fine shreds by a rapidly revolving circular knife brought down upon them by suitable mechanism at the proper intervals. The cutting is thus more cleanly effected, without the bruising which occurs when the separation is effected by the chopping action of the long knife usually employed. 6. A gas-engine, for small powers. The explosion of the gas is not effected in the cylinder or intermittently, but is performed continuously in a separate vessel, into a continuation of which water is injected, and the resulting steam and hot products of combustion work the engine in precisely the same way as steam works a steam-engine. This species of gas-engine is of small size, relatively with the power produced, and can be sold at a moderate price.—*Ibid.*

STEAM PAVING MACHINE.

A Steam Paving Machine has recently been introduced in Paris, and made use of by the municipality for the repair of the streets of that city. This machine consists of a small steam-engine on wheels, drawn by one horse, to the rear of which is attached the "paviour," which is forced upon the ground by a blow from the piston, and slides on a bar some 6 ft. long, and can thus be directed by the driver to any stone which requires forcing home. This machine was lately at work in the Rue de Grenelle, and is considered a success.

ENGINEERING AND MACHINERY IN WEST YORKSHIRE.

The following intelligence dates from Leeds the middle of November 1870: While the various large ironworks of the West Yorkshire district are for the autumn unusually busy, it is a striking fact also that, despite the war, which has been a great disadvantage to many other industries, the engineers and machine and tool makers of the same neighbourhood are briskly engaged in meeting the demands, not only of home, but of foreign customers. At the Airedale foundry and engine works (Messrs. Kiston & Co.), the senior partner in which firm is the oldest locomotive maker now living, 40 locomotives have been made for Russia. The work has been pushed forward very much lately in order to get the number completed before the stoppage by ice of the northern navigation. Two smaller engines have also been made for the new narrow gauge, which has to some extent been adopted in the country of the Czar. Locomotives are in progress, too, at these works for the Scinde Railway Company. The moulding, fitting, and erecting shops are busy hastening forward the completion of two powerful Cornish pumping-engines—one for the Wakefield and the other for the Scarborough Waterworks. An hydraulic pumping-engine, on a new plan, which is to be worked in some Cumberland mines, is in an advanced state. For the special machinery made in Leeds there is an extraordinary inquiry. Messrs. Greenwood & Batley have large orders on hand for cartridge and ball machinery, as well as for every species of mechanism necessary to the production of small arms, whether they be such as are the choice of our own Government or of the Turkish, Austrian, Danish, &c. The Spaniards have given out an important order in this department. Messrs. Greenwood & Batley have also on hand a large gun-factor for the Council of India. By this is meant that they have to provide everything for the construction of the Indian field-gun, its ammunition, and projectiles. The silk machinery of this firm, notwithstanding its high price as compared with the workmanship of other inventors and machinists, is now in far greater demand by the home silk-spinners than it has ever been. Very important improvements have recently been made in their celebrated machines for working both long and short dressed silk.

Though the war has to a great extent interrupted the foreign silk trade, the Swiss are still able to send orders for these new machines. The orders offered last week by the French to Leeds hackle and gill makers, for unlimited supplies of chassepot needles, have, as was anticipated, been transferred to Switzerland.

A NEW STEAM SAWMILL.

A NEW sort of Circular Sawmill has recently been started in one of the forests in the vicinity of Worcester, United States, and is described in the *American Railway Times.* The saw (some 5 ft. diameter) is placed directly upon the crank-shaft of the engine, thus doing away with the expensive and troublesome belt usually employed. The cylinder is placed vertically directly above the crank, at the top of a pedestal-like frame, and works a 7-in. piston upon a 5-in. crank, by means of the usual connections. A 600-pound flywheel is placed upon the same shaft with the saw. This is a plate-wheel, and is turned all over, to ensure perfect balance. The improved log-carriage and setting device is employed, and has a sufficient variety of feeds to answer all emergencies. This is said to be a simple and satisfactory portable sawmill.—*Builder.*

AUTOMATIC GRAIN-BINDING.

MR. CARPENTER, of Fond du Lac, Wisconsin, has succeeded in putting into the field an automatic machine, which will cut, bind, and deliver its thousands of bundles of grain, without the aid of human hands, and without wasting a kernel. Trials made during the recent harvest showed that, out of nearly 3,000 bundles, not above eight or ten would need rebinding; these had straw so short that it was difficult to get the cutter far below their heads. Three acres were cut in 2½ hours, without a bundle being missed; and it is believed that in an ordinary clear and level field a span of horses would easily cut and bind eight or ten acres daily, and probably more. One or two small accidents happened, but were speedily repaired. It is not possible, in a new and untried machine, to calculate all the points of greatest strain before they are demonstrated on trial. None of the defects had anything to do with the principle of the binder, but were merely deficiencies in the strength of one or two parts.—*Chicago Republican.*

MOTIVE POWER FOR MACHINERY.

AT the last exhibition of the American Institute it seems there was shown an elliptic lockstitch Sewing Machine driven by an Electric Engine small enough to fit into a common hatbox. A series of eight magnets are set on the periphery of a circle, and around these revolves an armature of steel which is continuously propelled by the magnetic action, and thus operates the machinery that moves the needle. Connection with this motor is had by means of a small slide within reach of the operator, at whose will the current may be cut off entirely or the speed of the needle graduated as may be desired.

JACKSON'S IMPROVED VELOCIPEDE.

Among the many inventions recently patented for Velocipedes, we notice one by Mr. W. Jackson, of Caroline-street, Pimlico, who proposes to construct his vehicle with four wheels; two of them, the front ones, being very small compared to the hind wheels, between which the rider or riders sit. There is no doubt but that a great speed could be obtained with this machine with perfect safety over ordinary roads. The riders work oscillating levers by means of their feet, which communicate a rotatory motion to the cranks on the hind axle. The fore carriage, to which the front wheels are affixed, is capable of being turned in any direction for guiding it, the stem or "perch" passing through the frame. The inventor tells us that he has travelled fifty miles in a day of ten hours in one of these machines without the least fatigue.—*Mechanics' Magazine.*

NEW PILE-DRIVER.

A very ingenious Pile-Driver has been invented in America, in which the motive force was derived from the explosion of gunpowder. A gunpowder-hammer has now been contrived upon the same principle, which may in some cases be used beneficially instead of the common steam-hammer. It is pretended that by this species of hammer the pressure upon the iron is continued longer than in common steam-hammers, whereby a kneading action is produced that affords time for the molten impurities to escape. There is very little doubt that a hydraulic kneader would be better than any existing species of hammer, as a sudden impact is not so effectual in removing impurities as a slow pressure.—*Illustrated London News.*

RECOVERY OF TREASURE.

Captain Lodge has returned from China with his divers, after the most successful expedition of the kind that has ever come under our notice. The ship *Hamilla Mitchell* was lost in August 1869 on the Leuconna Rocks, near Shanghai, and Lloyds' agent in his report considered the cargo and treasure hopelessly lost, as the depth of water was so great and the position too dangerous for working. Captain Lodge, however, undertook the task, and left England in March last with two experienced divers—Messrs. R. Ridyard and William Penk, of Liverpool. The diving apparatus, on a new principle and specially constructed for deep sea diving, was supplied by Messrs. Siebe & Gorman, submarine engineers. Upon their arrival at Shanghai, Captain

Lodge engaged the pilot cutter *Maggie*, and proceeded to search for the wreck. This operation had to be effected by means of a boat, as the larger vessel could not proceed so close to the high rocks. The diver at length, after a search in various depths, varying from 120 ft. to 145 ft., found the wreck, where the after part containing the treasure had rolled into deep water—viz., 23 fathoms or thereabouts. After some difficulty Ridyard succeeded in obtaining access to the treasure-room, where he found that some of the dollars were lying in heaps, the worms having eaten the wood boxes so that they were completely riddled. After four successful trips, the last of which proved the most advantageous, he having worked four hours consecutively under water, he sent up the contents of 64 boxes, and returned on deck quite exhausted from having worked so long at the great depth mentioned, a feat which was never performed by a diver before this occasion.—*Times*.

RAISING SUNKEN VESSELS BY BALLOONS.

OPERATIONS have been commenced in the Mersey by Mr. Maquay, of Messrs. Bewley & Webb's, of Dublin, to raise the steam-tug *Brother Jonathan*, which is sunk at the southern extremity of the Prince's Stage, Liverpool. There will be 4 balloons calculated to lift 40 tons each. 20 to lift 20 tons, and 12 to lift 10 tons—total, 680 tons. The balloons are supplied by a number of gas generators, and when the latter have been "charged" to the balloons affixed, an apparatus is to be lowered to the sunken vessel and fastened to it by an iron bolt, and the formation of the hydrogen gas in the generator will be commenced, which will inflate the balloons and cause them to rise, the vessel rising with them.

MOVING A WINDMILL ENTIRE, FOR SIXTEEN MILES.

A NOVEL experiment, though not quite so sensational as the moving of a hotel at Chicago, has been the removal of a wind flour mill, with all its fittings, from Westacre to Clenchwarton, Norfolk. The mill is a wooden structure, and, with its machinery, of enormous weight. It stood upon wheels, and having been purchased by a man living at Clenchwarton, he determined to endeavour to draw it along the road by a traction-engine, but all efforts to find one strong enough proved ineffectual; the application, however, of a powerful steam cultivation engine proved more successful. In passing along the route various expedients had to be tried, such as in ascending a hill the engine proceeded to the summit, and then pulled the mill up with a chain; and so carefully had the task to be performed that it occupied three days to make the journey. In crossing the Ouse, it was feared the celebrated long bridge would not be strong enough, but the engine having first passed over, the mill itself was drawn over, the bridge timbers creaking.—*Builder*.

DRESSING MILLSTONES.

Golay's machine for dressing millstones by a rotating wheel armed with a diamond as the cutting-point, which was exhibited in Paris in 1867, has come into extended use in this and other countries. One main secret of its success has been the use of bort, a species of amorphous diamond, instead of the crystalline diamond such as glaziers use; and other forms of apparatus have now been introduced, in which the same cutting material is employed, but in which the motion of the cutting-point, instead of being circular, is longitudinal, as in a planing or ruling machine. This last species of apparatus is now being pretty widely adopted. But other forms of apparatus could be designed which would equally satisfy the required conditions. The essential point in the invention is the acquisition of a durable cutting-point. That attained, the mechanical details for its application become obvious, and various alternative forms of apparatus may be employed.

NEW MOTIVE POWER.

A paper has been read to the British Association "On certain Mechanical Improvements in Obtaining Motive Power" by Mr. Eaton. He recalled to mind his description of the Warsop aëro-steam engine at Exeter, and his promise to communicate the results of further trials of the system, which had now been made in several places. A well-known Lancashire firm had built one of the engines for use in their own works, and had used it at a consumption of 60 cwt. of coal per week with the air, as against 86 cwt. per week when the air was shut off. Without the air an average pressure of 33½ lb. was shown; with it a pressure of 47 lb. An engine of the best construction, built for himself in London, showed with the air a gain of 24½ per cent. in work done at ordinary speed, and a gain of 33½ per cent. at a higher speed. The consumption of ordinary Welsh engine coal was, with steam only, 5·88 lb. per actual horse-power per hour; with steam and air, 4·72 lb., or a gain of 1·16 lb. per horse-power per hour, a very valuable economy. Experiments were at present being carried on with locomotive engines; and some experiments with condensing engines, made at the suggestion of Professor Rankine, showed the vacuum to be much less interfered with than had been expected, and that the extra steam generated counterbalanced the loss of vacuum, while the fuel consumption was alike under the two principles. The inventor was convinced that he could improve the condensing engine proper, and his perseverance has lately been rewarded by a success that will prove an invaluable boon to all owners of steam vessels. The paper concluded by an expression of appreciation of the facilities that had everywhere been afforded, especially by the authorities of the Admiralty, for testing the invention.

THE RAILWAY SYSTEM.

Mr. Vignolles, in addressing the British Association upon this subject, commenced by alluding to the fact that that day 40 years ago the Liverpool and Manchester Railway was opened. He (Mr. Vignolles) was personally concerned in that interesting event, which was mainly due to the public spirit of the merchants of Liverpool, and to the tact and unwearied energy of the late Henry Booth. It was a curious fact that the British Association and the railway system had their birth in the same year, and Liverpool was, therefore, a most appropriate place for its fortieth annual meeting. Alluding next to the fact that the section was the one in which science as affecting military and naval matters afforded subjects of discussion, Mr. Vignolles said, "I think I shall be disabusing the minds of many who have supposed this country is not prepared, or that the Government have been unaware of the necessity for creating the best means of communication in the event of invasion or war, by stating that for several years the military department at the Horse Guards and the chief engineers of the country have been in constant communication, and have formed deliberate arrangements by which, in the event of any casualty occurring, such as the invasion of the country, the whole of the military forces of the country—100,000 men—if we had them at our disposal, might be in 48 hours brought to any one point of assault." Mr. Vignolles next pointed out by extracts from Kinglake's *Crimean War* that in fine weather, without opposition, and under the guns of the fleet, it took five days to land 26,000 troops, 1,000 horses, and 60 guns. These facts, Mr. Vignolles said, would, he hoped, be some consolation to the old soldiers and old women as to our alleged "want of preparation."—*Times.*

RAILWAY GAUGES.

The following papers have been read to the Mechanical Section of the British Association:—"On the Gauge of Railways of the Future," by Mr. R. J. Fairlie.—The author's argument was to show that a 3-ft. gauge line could carry, and had been proved to carry, two and a half times as many tons of traffic as were now, for instance, carried over the 4-ft. 8½-in. gauge of the North-Western Railway, and this without an additional shilling for haulage. Every inch added to the width of a gauge beyond what was absolutely necessary for the traffic would necessarily add to the cost of construction, increase the proportion of dead weight, increase the cost of working, and in consequence increase the tariffs to the public: thus, by just so much reducing the width of the line, railways could be made cheaply, and at the same time thoroughly efficient. There was no country too poor to have railways sufficient for its requirements, and they furnished the cheapest possible mode of transport.

Mr. J. B. Fell read a paper commendatory of the narrow in opposition to the broad gauge principle, and also on the application of the centre-rail system to mountain lines, as in the case of the Mont Cenis line and of a railway in Brazil. He said about forty millions sterling had been invested in lines that had proved hitherto unproductive; and if the total capital expended on broad-gauge railways had been laid out on narrow lines, about double the actual length could have been laid down for the outlay. To illustrate the economy and carrying capacity of a narrow-gauge line, he had constructed a mile of lines on an 8-in. gauge, at Low Furness, in Lancashire, at a cost of 1,000*l.* It was capable of carrying from 100,000 to 150,000 tons a year; and it would run at the rate of 15 to 20 miles an hour with steadiness and perfect safety. This plan of railway would be especially useful for military purposes in such expeditions as that in Abyssinia; and he had submitted his plans to the War Office authorities, who now had them under consideration.

THE ORIGIN OF THE LOCOMOTIVE.

In the matter of priority of invention, or, rather, attempts at land propulsion by steam, the French may well claim to be our *devanciers.* The first steam carriage seems to have been made by a Frenchman, Cugnot, in the year 1769—that same marvellous year which witnessed the birth of Napoleon I., Wellington, Humboldt, Mehemet Ali, Lord Castlereagh, and the first patent of Arkwright, the first patent of Watt, as also some other events almost as great in their eventual influence on the present era. An engine made by Cugnot is still in existence in the Conservatoire des Arts et Métiers at Paris. It has a copper boiler, very much like a common kettle without the handle and spout, furnishing with steam a pair of 13-in. single-acting cylinders. The engine propels a single driving-wheel, which is roughened on its periphery. Although this engine bears considerable testimony to the mechanical genius of its inventor, it was unsuccessful, having got overturned once or twice on the very bad roads then existing in France, and it was put on one side. It was stated, however, that arrangements were made, in 1801, to put it to work in the presence of Napoleon Bonaparte. The departure, however, of Napoleon for Egypt prevented the trial, a circumstance which recalls Fulton's subsequent unsuccessful negotiations with Napoleon for aid in attempting marine propulsion by steam. Watt then, in 1784, patented a locomotive engine, the boiler of which was to be of "wood," hooped like a beer-barrel. Watt, however, had not much faith in steam carriages, and he objected to the attempts made in this direction, in 1784, by William Murdoch, his very able assistant. The miniature engine made by Murdoch in that year is still in existence. Careful and elaborate researches, such as those made by the late Zerah Colburn, into the history of the locomotive, seem to more and more confirm existing impressions as to the great part done by Trevethick in the introduction of the locomotive engine.—*Mechanics' Magazine.*

LOCOMOTIVES WITHOUT RAILWAYS.

It appears, by the Reports on Thomson's "Road Steamer" made to the War Department, that this engine, unless perhaps for hunting purposes, is far more useful than any horse. Mr. Anderson, the superintendent of machinery, says he has "come to the conclusion that the question of steam traction on common roads is now completely solved," that the application of the india-rubber tire is a perfect success, that it opens up an entirely new field, and that he looks upon this application as a discovery rather than an invention. The wheel and its tire may be described as consisting of a broad iron tire with narrow flanges, upon which is placed a ring of soft vulcanised india-rubber; this ring is about 12 in. in width and 5 in. in thickness, which thus surrounds the iron tire, and is kept in its place by the flanges; then over the india-rubber there is placed an endless chain of steel plates, which is the portion of the wheel that comes into actual contact with the rough road, the reticulated chain being connected by a sort of vertebra at each side of the wheel. The india-rubber tire and this ring of steel plates have no rigid connection, but are at perfect liberty to move round as they please without consulting each other, or even without the concurrence of the inner ring of the wheel which they both enclose. Mr. Anderson states that the reason why this wheel is so efficient is because the soft india-rubber allows it to flatten upon the road, whether rough or smooth. The wheel, being a circle, if it is a rigid structure, presents but a small surface, but this wheel conforms to every irregularity for a space of nearly 2 ft. by the weight of the engine causing the india-rubber to collapse, and so producing a change of form.

In the construction of the road steamer the greater portion of the weight, including the boiler, rests upon the driving wheels; the third wheel in front is for guiding the direction of movement, and is perfectly under control. In the course of experiments witnessed by Mr. Anderson the engine went up a zigzag labyrinth of courts, and it can describe any figure almost in a space of twice its length. The boiler employed is an independent invention adapted to the carriage. Its chief peculiarity is the copper pot for holding boiling water within the furnace, and it is so contrived that if the boiler contains any water the pot will have a full supply. This arrangement keeps the centre of gravity low, and allows the engine to run up hills of 1 in 10, or go along an angle of 35 deg. On the first day Mr. Anderson saw it in Leith the streets were very wet and adhesive. A train of waggons containing 10 tons of flour, besides their own weight, were standing at the bottom of a slippery street, with a gradient of about 1 in 17; to this train the little engine was attached, and away it marched as if it had no load, went up to the top of the hill, and then down on the other side, no breaks being required. After depositing its load somewhere in Leith, it ran down to the

Portobello seashore at the rate of ten miles an hour. On surveying the sands, Mr. Anderson says, it seemed an impossibility that it could walk on such soft sinking ground, but on it rushed through all, over some quicksands, ran into the sea and along its edge in every direction in the most wonderful manner. It then, after returning from the seaside, removed an old boiler from the docks to a yard at some distance. The boiler and waggon, with the fastening chains, weighed upwards of 22 tons, and the boiler on the waggon stood some 25 ft. high. Up to this the engine backed, then marched off with its load along the quay, over a rising swing bridge and along other quays, until it reached its destination. The charm of the performance, Mr. Anderson remarks, was in the way in which it was done. No shouting, no refractory or desultory pulling of horses, but by the expenditure of a few pounds of coals and water the whole was accomplished with ease and celerity; and so accustomed are the people in Leith to its performance that no notice was taken of it except by the country horses, for the town horses seem to know that it is their friend rather than their enemy.—*Pall Mall Gazette*.

FAIRLIE'S DOUBLE BOGIE ENGINE.

EXPERIMENTS for testing this new engine have been made on the Festiniog Railway, the gauge of which is only 1 ft. 11½ in. The ordinary engines weigh about 10 tons, coaled and watered, and the tenders a little over a ton. The passenger carriages are about 6 ft. wide and 6 ft. 6 in. high in the centre, with seats for 14 passengers. All the new carriages were made with cross seats, and carry 3 on each seat. The passenger carriages and goods trucks carry about three times their own weight of paying load. The carriage wheels are 18 in. in diameter, and the floors of the vehicles only about 7 in. above the roadway. The experiments had two distinct objects—to test, first, the comparative smoothness and steadiness of the Fairlie engine against the ordinary engine while remaining on a straight and level road, because in the opinion of many the Fairlie engine was admitted steady on curves, but by reason of the bogies it was thought it would be unsteady on the straight, which was clearly demonstrated to be a fallacy; and, secondly, their power. The Fairlie engine, it was shown, could work on rails of much less weight and require much less maintaining than any ordinary engine of the same weight for wheel. The next test related to the comparative power of the two classes of engine. "The Welsh Pony" was yoked to a train of 77 slate trucks, the weight of the train being 193 tons 13 cwt., exclusive of engine and tender. "The Welsh Pony" and engines of the same class are about 10¼ tons in weight, and their tenders about a ton and a quarter, coaled and watered. Mr. Fairlie's "Little Wonder," which represents two engines, both exercising traction power, weighs about 19½ tons. The Pony broke down. Nine trucks were taken off, and the 31 were managed by the Pony. The same 77 loaded trucks were taken in tow by the "Little Wonder," and were carried at a brisk pace through everything, until it was purposely stopped to return to Portmadoc, having clearly shown its power of taking the load right away. The "Little Wonder" took a very long train to Festiniog, 414 yds. It consisted of 125 trucks, 7 passenger carriages, and a boat carriage, besides the engine. The weight of the train was 114 tons. The distance between Portmadoc and Festiniog was rather less than 14 miles. The continuous rise was by gradients of, for the greater part, 1 in 85. The train was on as many as five curves at one time, and on several occasions the engine was moving in a completely opposite direction to the last 20 waggons. The opinions in favour of the Fairlie engine were strong and unanimous, and decidedly favourable to the bogie, as being much more steady and powerful than the ordinary engine, and as furnishing a solution of the problem how to supply with railways that would pay the districts and countries as yet unprovided with them. Mr. Spooner, the manager of the Festiniog Railway, stated that there was a saving of 50 per cent. in favour of the double bogie Fairlie engine on the weight hauled. Mr. Roberts, of the Brecon and Merthyr Railway, stated that the "Progress" (Fairlie's double bogie), with a consumption of 34 tons 6 cwt. of coal, hauled 6,600 tons in the same time as the "Cyclops" or "Severn" hauled 4,576 tons, with an average consumption of coal of 31 tons 13 cwt.; or, in other words, the "Progress," with a consumption of 9·7 per cent. more coal, did 44·5 per cent. more work, the total cost for the "Progress" being 7·18*d.* per mile, while the average of the "Cyclops" and "Severn" was 6·34*d.* The "Progress" did 44·5 per cent more duty at an increased cost of only 0·84*d.* per mile, or the total cost of hauling the 6,600 tons with engines of the "Cyclops" or "Severn" class would be 35*l.* 11*s.* 3*d.*, as compared with 27*l.* 19*s.* 9*d.*, the cost of haulage with the "Progress." —*Times.*

SIR JOSEPH WHITWORTH ON RAILWAY AXLES.

The sad railway accident at Newark, caused by the breaking of a Railway Axle through unsoundness of material, which has caused the death of eighteen persons and the destruction of much valuable property, must make railway directors extremely anxious to adopt all possible means of detecting and discovering unsoundness in the material used for railway carriage axles. The best method that can be adopted for the purpose is that of drilling a hole through the centre of the axle, throughout its length, thus opening up to inspection and examination that part of the material which, in the case of ordinary manufacture, is most subject to unsoundness. The hole should be about 1 in. in diameter, and, with suitable mechanical arrangements, might be drilled at an average cost of about 1*s.* 6*d.* per axle. With the outside turned and the inside thus exposed to view, a serious flaw in an axle, which is only about 4½ in. in diameter, could hardly escape discovery. The plan would also diminish the tendency of the axle to get heated, and, by removing the material near the neutral axis, would, under the circumstances, reduce the internal strains and render the axle safer. It is of great importance both to give proper diameters to every portion of the length of the axle, and to avoid all approach to sudden change of diameter.

CYLINDRICAL IRON RAILWAY CARRIAGES.

A NEW Carriage for Passengers has been patented by Mr. W. N. Macartney, of Glasgow. It is made of wrought-iron firmly riveted in the form of a cylinder, partaking more or less of a complete circle in its cross section, as the strongest shape into which a given weight of metal can be put. The doors may be made in the side, but they are arranged, as most suitable, in each end, opening out into a platform, which, when the train is in motion, serves as a means of communication through all the carriages. The openings for the windows are in the same position as in ordinary carriages, and the seats can either be made across or along the carriage. In either case, owing to the slightly increased breadth, a passage is left from one end of the carriage to the other. The iron plates of the carriage, owing to the circular shape, require little if any framework, and the few ribs necessary are utilised for ventilation. All the interior is cushioned, except the floor, with non-conducting and non-combustible material. Stoves are provided for heating. The platform is utilised as a great collision buffer. The roof is extended over the platform, and while serving as a cover, is also a buffer, on the same principle as the platform underneath. For his invention the patentee claims many advantages.—*Builder.*

NORWEGIAN RAILWAY.—FIRE BRIGADE.

ON August 20, the Duke of Sutherland returned to Dunrobin Castle from his inspection of the Norwegian Narrow-gauge Railways, which his Grace made in company with Mr. Fowler, of Braemore. Upwards of 100 miles of railway on the 3 ft. 6 in. gauge have been constructed in Norway by Mr. Carl Pehl, the Government engineer, and they have been most successful for the light traffic of that country in their economical construction, and the convenience of their smaller carriages and waggons. The supporters of this system have no doubt that, if the northern parts of Scotland could have had the advantages of such a cheap description of railways, a much greater extent of the country would before now have been supplied with railway accommodation. The average cost per mile, including plant, is about 4,000*l.*, and the works of the railway and stations and the quality of the plant are said to be all that could be desired for public convenience. On the afternoon of his Grace leaving

Christiania the authorities of the town requested that he would review the Fire Brigade, which, with his usual kindness, the Duke immediately consented to do. The arrangements of the brigade at Christiania are unusually efficient for a town of 60,000 inhabitants. A body of 52 firemen under Captain Andersen are on daily duty, and a body of 1,300 trained volunteers are quickly available (on a signal of guns firing) to work the fire-engines. From the central office in the market-place a telegraph communicates with three main stations, and 36 subsidiary ones are in different parts of the town. The review consisted in calling out the firemen and engines from each station to the site of an imaginary fire near the University, where all the operations of water supply thrown on a model house, ascending by ladders, sending them down fire-escapes, &c., were gone through with great energy and rapidity. Captain Andersen and his crew were delighted with his Grace's practical knowledge of everything connected with their work, and they expressed their gratification that they had been reviewed by one who had done so much to encourage improvement in the machines for saving life and property from fire. On the conclusion of the review, which exhibited much smartness of drill, the men were drawn up in line, and, at the suggestion of their captain, gave three hearty cheers for the Duke of Sutherland.—*Inverness Courier.*

THE TRAMWAYS OF LONDON.

In the Report of the District Surveyor of the Holborn Board of Works, he proposes that Tramways should be composed of blocks of granite stone, laid end to end, in 6 ft. lengths, and with a wearing surface of 18 in.; that the inner edges of the stones should be 4 ft. 6 in. apart, and this space should be paved with granite cubes 3 in. wide, and of the same depth as the tram stones, 9 in.

There should be a clear space of 2 ft. between the two lines of trams, and this, with the remaining width of the street, should also be paved with granite cubes. That the whole should rest on a substratum of concrete, composed of hydraulic lime and clean Thames ballast, and be of the uniform depth of 12 in. all over.

In setting out the trams, the centre of the street should be found, which should serve as the centre line of the 2 ft. space; thus, the trams would approach to or be removed from the footway, according as the width of the street increased or diminished. The whole width of the two lines of trams and the space between would be 17 ft., which would leave ample margins on each side in streets of such width as Oxford Street and Holborn. In clearing cab ranks or safety crossings, placed in the middle of the road, the trams would be inclined towards the footways until the obstructions were passed.—*Mechanics' Magazine.*

PNEUMATIC TUNNELS AND PIPES.

Colonel Sabine has read to the British Association a paper "On Pneumatic Transmission through Tunnels and Pipes." He said that for the purposes of transmitting light parcels by means of pneumatic tunnels, he would employ hydrogen gas in the proportion of 1 to 2½ of atmospheric air, than which it was a better agent, and the plan would be economical by reducing the size of the large tubes required when common air was employed. Small pneumatic tubes might be worked more profitably than large ones, and the working of small tubes for transmitting letters between the several post-offices in London and other large cities had already proved their economic practicability. As to applying the principle to railway traffic, passengers and goods, he did not believe that a pneumatic line working through a long tunnel could ever be applied so economically as to be equivalent to steam power.

THE CHRONOGRAPH.

A **Chronograph** for recording the speed of a cannon-ball fired from a gun, at different parts of its course, has been for some years in use: one invented by a Belgian officer; another, the best of its kind, by the Rev. F. Bashforth, of Plumstead. But something more than this was wanted—namely, to know what was the movement of a projectile within the gun itself; and this something more is accomplished by the chronoscope invented by Captain Andrew Noble, of the Elswick Ordnance Works, Newcastle-on-Tyne. It is a singularly ingenious machine. It comprises wheelwork, set in motion by a heavy weight, a dial which indicates the rate of motion, and a series of discs rotating on a common axis. Immediately in front of the edge of each disc is placed the terminal of an electric wire, the other end of which is connected with a gun, at perhaps fifty or a hundred yards distance. Through the sides of the gun, at regular distances from breech to muzzle, iron plugs are screwed. In the centre of each plug works a piston, which, by pressure against its inner end, can be pushed slightly outwards: to its outer end the wire is attached. When all is ready, the discs of the chronoscope are made to rotate by the wheelwork with great velocity,—the gun is fired,—the ball, or projectile, as it rushes along the bore pushes the inner ends of the pistons one after the other,—the outer ends give a slight jump, sufficient, however, to cut the wires thereto attached, and by this cutting a spark is on the instant produced at the terminal on the chronoscope. The edges of the discs are coated with white paper, under a film of lampblack. The spark burns off a minute speck of the black, and discloses an equally minute speck of the white paper. The first spark comes, of course, from the wire nearest the breech, and the last from the one nearest the muzzle, and from the intermediate ones in their order. The time between one and the other is almost inconceivably small; but as the chronoscope will measure the hundred-thousandth part of a second, the movement of the projectile along the gun is accurately recorded by the specks on the discs, and is read off on a scale to four to five places of decimals. At Burlington House the gun was represented by a service rifle charged with gun-cotton, which makes no smoke; but the results were similar to those produced by one of the 300lb. projectiles fired at Woolwich, and excited much admiration. They were witnessed also on the following Monday by Mr. Childers and a select party of naval and military officers, who now understand that by the experiments already made with the chronoscope, our knowledge of the behaviour of different kinds of gunpowder has been so much extended as to lead to greater efficiency with less cost in artillery practice; and at the same time the experimentalists are arriving at conclusions as to the pressure of the gases on the inside of the gun.—*Mechanics' Magazine.*

AN AERO-STEAM ENGINE.

This is the invention of Mr. George Warsop, a working mechanic at Nottingham. The essential feature of the arrangement is the addition of an Air-pump to an ordinary High-pressure Steam Engine. Air condensed from this pump is driven into a tube, which is carried at first within the exhaust steam pipe, next in a spiral course within the funnel, and finally enters at the lower part of the boiler, where it terminates in a large circle, pierced by numerous very fine openings, from which the compressed and heated air bubbles up through the water, imparting heat to it, breaking up its cohesion, and, so to speak, preparing for its ebullition. The experiments, which were made some time since by Messrs. Easton and Amos, showed that this invention saved 47 per cent. of fuel. It has now been applied to marine engines, and an experiment has been made with the *Fox*, an iron screw steamer which has been built for the coasting trade. It was found that the system prevented "priming," a result which resembles the boiling over of a saucepan. Arrangements have been made to compare for several months the performances of the *Fox* with those of another vessel belonging to the same owners, but to which the invention has not been applied. The *Times* says the system has as yet only been made profitably applicable to high pressure boilers, but the inventor feels sure of being able to apply it also to condensing engines. If it should be found to fulfil only half its present promise, it will effect an annual saving, the amount of which it would be almost impossible to calculate, and its use would become a matter of necessity wherever the profits of manufacture are curtailed by the influence of competition.

NEW APPLICATION OF STEAM.

An experiment has been made at the Easter-road Barracks by the Edinburgh Militia Artillery, which is noteworthy as probably the first time that heavy guns of position have been handled with ease and rapidity without horses, bullocks, or elephants. By means of Thomson's road steamer two guns of 50 cwt. were moved at six miles an hour, and wheeled while moving at that rate in a space eight yards in breadth. They were placed in position with a precision and rapidity that could scarcely be attained by any other means with guns of equal weight. This, it may be remarked, is the first time that Thomson's road steamers have been actually applied to heavy artillery. It is extremely probable that they will be largely used in future military operations. We understand that a number of these engines is being made for the British and Indian Governments, and that they will in future probably be in constant use by all civilised armies.

FRICTION OF STEAM ENGINES.

The difficulties which lie in the way of ascertaining by actual experiment what the Frictional Resistance of an Engine is are very great, and to this cause no doubt is to be attributed the greater portion of the existing ignorance of the subject. The obstacles in the way are of two kinds. In the first place, it is very difficult to put a dynamometer or brake on large engines whereby to ascertain their duty; and, in the second place, the amount of friction varies not only in different engines, but in the same engines in a very extraordinary way. As regards the first difficulty, we can, in the case of pumping engines, ascertain precisely how many foot-pounds of work an engine actually gives out in the shape of useful effect, while the indicator shows the work done in the piston; but from these data it is impossible to calculate engine friction exactly, because our calculations are complicated by the greater or less efficiency of the pumps. It is possible that nothing can be more deceptive than the results obtained from pumping engines, and therefore we have no hesitation in rejecting their aid in dealing with questions of engine friction. Practically, the only generally available test is the indicator used with the engine light and the engine loaded; but diagrams taken thus do not account for the extra friction due to the performance of work, though useful to some extent in their way; but no investigation of the qualities of an engine can be regarded as complete unless the dynamometer is used as well as the indicator.—*Engineer.*

NEW STEAM GUN.

The idea of a Steam Gun to throw a hail of bullets is not altogether a new one, but in a long letter to the *Times* Mr. Henry Bessemer revives it, and strongly recommends that it should be carried into practice. He calculates that the force of a steam fire-engine is sufficient, if properly applied, to throw 2,540 Enfield bullets one mile in vertical height per minute, with an expenditure of about 5 lbs. of coal and three gallons of water. He therefore proposes the construction of small engines, capable of easy movement from place to place, and working at a pressure of about 150 lbs. on the square inch. The steam at such a pressure would escape at the rate of about 1,900 ft. per second, and this, he calculates, would impart to a bullet an initial velocity of at least 1,600 ft. per second.

STEAM ROLLERS.

THE Surveyor to the Poplar District Board of Works, in presenting his usual reports, specially called attention to a report on one of Messrs. Aveling and Porter's Steam Rollers for consolidating the roads. The report states that nearly 57¼ tons of material were consolidated per day. The maximum quantity of broken granite and Bombay stone used in one year throughout the district is 4,723 tons, which would employ the roller in question 82½ days, or little more than three months in the year. The surveyor is of opinion that for the present it is better to hire than to purchase the roller. As to the advisability of using it, he said there could not be two opinions. The short experience they had had of its utility was very satisfactory, and the additional cost over the old system of repairing is not 1¼*d*. per square yard, which would be more than compensated for when the work was once done, over and above the decided advantage experienced to the carriage traffic, and, he might add, to the public generally. The chairman suggested the sending of a communication embodying their experience of the use of steam rollers to the Commercial-road Trustee Board, and the clerk was desired to carry out the suggestion forthwith.—*Builder*.

SPHERICAL STEAM ENGINE GOVERNOR.

A NEW and original form of Steam Engine Governor is now being introduced to public notice by Mr. John Bourne, whose inventions are always of such an essentially practical nature as to command both attention and success. The action of the governor primarily depends upon an elastic sphere of brass, which changes its figure during rapid rotation. This change of figure is made to act upon the throttle-valve. and so to regulate the speed of the engine. This ingenious apparatus contains a hollow sphere, which is made of thin brass, rendered elastic by hammering and divided into segments. On one end of the central spindle is a brass nut, which is prolonged outwards and terminates with a small hand wheel. By means of this wheel and nut the valve is opened or shut, and by it also the point of cut-off is regulated. The spindle is screwed into the valve, and both are prevented from revolving by a flat rib, which is cast on the under side of the valve cover, a similar rib being formed on the valve, and with which the rib on the cover engages. On the extreme end of the spindle is a nut, which keeps the hand wheel and nut in the position in which it is set. This nut also serves a second purpose, that of a lubricator, being fitted as an oil cup. The brass is turned with grooves and forms a thrust bearing for the upper part of the sphere in a manner similar to that adopted for screw propeller shafts. The ribs of this brass work in corresponding grooves in the metal gap which encircles them, and to which the upper portion of the brass sphere is attached. The base of the elastic sphere is attached to a sleeve, which is made in one with the pulley, over which a gut band from the crank shaft of the engine passes, and which gives rotation to the ball. The sleeve revolves freely upon the fixed portion of the valve casing, and is prevented from rising upon it by a collar, which is fixed by a side screw to the end. The governor may be made to operate on any other kind of throttle valve, and can be fitted to existing engines. It will be seen that when the ball is put into revolution the centrifugal force causes the poles to approach each other. As, however, the lower pole is confined to the same horizontal plane, the whole vertical motion occurs at the upper pole, and depresses the spindle and closes the throttle valve to a corresponding extent. The action of this governor is very perfect, it being extremely sensitive, as was evidenced by one which we lately examined at Mr. Bourne's offices, No 66, Mark-lane, London. Whilst the governor was worked at a regular steady speed the valve remained open; on suddenly increasing the speed, however, the sphere became depressed and the valve closed. The governors are made with spheres 6 in., 9 in., and 12 in. in diameter, being proportioned for 3 in., 4½ in., and 6 in. steam pipes. Mr. Bourne's governor may be fitted to any engine, stationary, marine, or locomotive, and one of its special features is that it may be worked in any position, either vertical, as represented in our engraving, horizontal or inverted, or at any intermediate angle, gravity having no effect upon its action, as with most ball governors. As a marine governor this apparatus is especially suitable, being unaffected by the rolling or pitching of the vessel. Mr Bourne has succeeded in producing an efficient, compact, and elegant apparatus, which will doubtless come into extensive use. It adds one more testimony to his ingenuity and mechanical ability, and like the rest of his inventions, is based upon correct and sound principles.—*Mechanics' Magazine.*

DANGERS OF KITCHEN BOILERS.

A CORRESPONDENT, in the *Builder* of March 12, points out "the great danger that exists in all closed Kitchen Boilers that are not provided with adequate safety-valves, whenever a frost occurs severe enough to freeze the water in the communication-pipes; but the article takes no notice of the danger of explosion from another source, which by most people would be quite unsuspected, —as it was, in fact, by me. I refer to the partial or complete stoppage of the pipes from a deposit of iron in the form of very hard concretions adhering most firmly all along the bore.

"Finding the action of my apparatus (which consists of a closed boiler supplying a bath about 13 ft. above it) unsatisfactory after being in use five or six years, I took it down, and found the pipes lined throughout with a solid irony concretion. Very fortunate it was for me that I did examine into the matter, for the concretions had in parts so nearly closed the bore of the pipes, that if I had continued the use of the apparatus a year or two longer, I am convinced the stoppage would have become complete, and an explosion inevitable.

"The water used is remarkably pure, containing no appreciable quantity of lime or iron, so that the concretions must have been derived from the boiler and pipes. That a deposit should take place might have been expected, but its extreme hardness and solidity did surprise me.

"It may be observed that such boilers supplied with calcareous water must be liable to the same danger, though I am not aware that any instances have been recorded.

"One object in writing, is to inquire how the report of the 'Manchester Steam Users' Association' may be obtained? as I observe your article quotes from their chief engineer a promise of entering on the subject of safety-valves for such boilers."—*Communicated to the Mechanics' Magazine.*

BOILER EXPLOSIONS.

At a meeting of the Midland Steam Boiler Inspection and Assurance Company in Wolverhampton, the engineer-in-chief (Mr. E. B. Marten) presented a Report, showing that as far as ascertained, and excluding domestic boilers, there had been 59 Boiler Explosions in the year ending December, 1869, causing the death of 87 and injury to 128 persons. The largest number of explosions have been at collieries or mines. The class of boiler which has most frequently exploded and killed and injured the greatest number, has been the "Cornish" or "Lancashire," or other similar boilers externally fired. Nearly the same number of plain cylinder boilers externally fired have exploded, but with less fatal results. The explosions have resulted from simple and well known causes, most of which could have been detected by inspection. Corrosion has led to the most mischievous results, also in respect of the number of boilers destroyed and lives taken. The report of the chief engineer (Mr. R. B. Longridge), of the Boiler Insurance and Steam Power Company, Manchester, computes the explosions in 1869 as 63, and the deaths 92. This is a considerable increase upon the previous year, for in 1868 the explosions were 43, and the deaths 57. The increase is confined to mines and ironworks.—*Mechanics' Magazine.*

PETROLEUM ENGINE.

Travellers in France who have an horror of petroleum, and dread a repetition of the Abergele accident, may possibly not be aware that they may happen to find themselves not only in the same train with their dreaded enemy, but actually being drawn at the rate of 50 miles per hour by its means. M. Dieudonne recently exhibited the model of a small Engine heated by means of Petroleum. This locomotive carries 2,000 litres of oil in the tender, a hand pump forcing the oil into a smaller reservoir near the boiler. The process of lighting the oil is said to be neither difficult nor dangerous, owing to the oil being kept in compartments, a small quantity only being lighted at one time, then another division, and so on, till the whole furnace is alight. This engine consumes its own smoke perfectly; it is said to be extremely easy to drive, the driving apparatus being very simple. A larger locomotive, with some small improvements, has since been built, and has actually drawn ordinary trains on the railway between Epernay, Rheims, and Bar-le-Duc. It drew a train of 14 carriages with ease, and has already travelled over 2,000 kilometres (about 1,250 miles) without accident. The consumption of oil was 35 per cent. less by weight than that of good patent compressed coal; 1 kilogramme—a little more than 2lbs. of oil produced 12 kilogrammes (25lbs.) of steam. The same system has been applied with success to the yacht *Puebla*.—*Mining Journal.*

EXPORTS OF PETROLEUM.

On June 4, seven ships loaded with crude and refined Petroleum cleared at Philadelphia for Europe, carrying 1,168,000 gallons. The total shipments from Philadelphia are 5,000,000 gallons this year (1870) in excess of the exports to the same date last year, but this does not tell all the facts. The oil fleets already chartered in New York and Philadelphia will take out of the country, between this date and the middle of July, the enormous quantity of 10,000,000 gallons of refined oil. This shipment will constitute, by two or three millions of gallons, the largest export of petroleum within the first seven months of any year since terrene oil became an article of commerce. One thousand barrels per day were added to the production of crude oil during May, and some parties maintain that the yield has increased 1,500 barrels per day; yet the vast shipments abroad seem to balance the large increase of production.—*New York Daily Bulletin.*

LIQUID FUEL.

Considerable interest is at present felt in the United States in connection with the substitution of Liquid for Solid Fuel, in but the·ence of the success which has attended the invention of

Messrs. Whipple and Dickerson, of Chicago. The distinctive peculiarity of this process consists in the evolution of hydrocarbon gas, which is conducted to the firebox, and there burnt from ordinary pipes, as in a gas stove. The process of evaporation is the chief feature of the discovery. Steam from the boiler passes through a pipe into the firebox, where it is superheated in a small iron cylinder to a temperature of 500 deg. to 700 deg., or to even a greater temperature if desired; thence it passes through a pipe to a cylindrical generator, some 4 ft. high by 2½ ft. in diameter, containing 600 copper tubes of small size. The superheated steam passes through these tubes while the petroleum is contained in the spaces around them. The intense heat here, of course, volatilises the oil with great rapidity, and the gas passes into a receiver enclosing the generator similarly to a water jacket. From this it rises through a layer of sponge, to equalise the pressure, into the dome of the machine, whence it passes into the firebox of the boiler, and is consumed through an ordinary frame of burners with a force and heat far superior to any produced by coal. The practical application of petroleum as fuel has been mentioned in the *Mining Journal*, and the value of petroleum, as compared with coal, was there carefully shown. Taking journeys amounting to 1,250 miles in all, which have been performed without accident of any kind, the consumption of oil was 35 per cent. less by weight than that of good patent compressed coal. Each pound of fuel consumed evaporated 12 lb. of water; than which a more satisfactory result could scarcely be hoped for. That the use of petroleum gas, and not of the petroleum in the ordinary condition, produces the best result appears to have been now established, and this opinion is in a measure confirmed by the excellent results obtained with natural petroleum gas under the boilers at the Erie Water Works. These are now heated solely by the flow of natural gas from the well recently sunk there. The gas is conducted by a 1½ in. pipe, without gasometer, through smaller pipes underneath the boilers. The flow has been steady, and less than one-half the amount has been necessary to keep up a pressure of 47 lb. of steam to the inch, the usual pressure required. No coal whatever has been used since its introduction, the costs it saves being from 8 to 10 dollars per day. Thus far it has only been conducted into the fire space under the boilers, but pipes will be put in to conduct it directly into the flues. Besides the saving of coal, the item of cleanliness is one worth taking into consideration. There is no smoke, no dust, no ashes, and nothing to do except turn a faucet to either shut off the heat or put on full force in a twinkling. Added to the intrinsic value of this well, the success in finding gas has opened a new channel of prosperity, and several prospects and enterprises, wherein the cost of fuel is the great item of expense, and whereby it may be made almost nominal, are already afoot, and doubtless some of them will be pushed through a fair trial. It is now proposed to bore specially for gas, to be used in the manufacture of iron, from which considerable economy and improved quality are anticipated.—*Mining Journal.*

UTILIZATION OF COAL-DUST.

Coal-Dust Furnaces are now coming into use in Wales and elsewhere. This class of furnace was first proposed by Mr. Bourne in 1815, patented by him in 1857, and again, with improvements in 1868, and introduced by the patentee in various cases, both in England and Scotland. The price of small coal has been gradually rising, partly from the introduction of this species of furnace, and partly from its consumption in the manufacture of patent fuel, which consists of coal-dust agglomerated by pitch obtained from the distillation of tar procured from the coal.

VENTILATION OF COAL-MINES.

The explosion which has occurred at the Morfa Colliery, near Port Talbot, in South Wales, has again directed attention to the importance of the better Ventilation of Coal-mines. At the neighbouring colliery of Cwm Avon, Mr. Struvé's ventilator is employed, and is found to act most effectually in keeping the workings free from firedamp. This apparatus consists virtually of two great blowing cylinders, each of 20 ft. diameter, set at each end of a working beam, to which a reciprocating motion is communicated by a steam-engine. Instead, however, of the cylinders being bored and fitted with pistons, they are formed of sheet-iron, like a gasholder and gasometer, and are made tight in like manner by water-joints. When the gasometer is raised by the beam the air is sucked through valves from the mine, and when the gasometer is again depressed this air is expelled into the atmosphere. The foul air is thus continuously pumped out through a shaft appropriated to that purpose, while the pure air enters through other shafts and openings, and is made to course through all the workings before its final debouch at the ventilator by which it is removed.—*Illustrated London News.*

IMPROVED SAFETY LAMP.

There has been exhibited to the Iron and Steel Institute an improvement on the Davy Safety Lamp, by the patentee, Mr. W. Yates, of Duke Street. By soldering a lens such as is used in a policeman's "bull's eye" into the gauze cylinder of an ordinary miner's safety lamp, and placing a reflector behind the flame, a light 20 times as strong as that given by the ordinary lamp can be obtained with a saving of 30 per cent. in the consumption of fuel. A further improvement has been effected with a view to prevent the fearful accidents which arise from the reckless exposure of the flame in pits filled with inflammable gases. By a very simple mechanical contrivance, an extinguisher is made to fall upon the wick when the lamp is opened.

INCOMBUSTIBLE WOOD.

In the *Annales du Génie civil*, of April last, Dr. Reinssh gives the following directions for rendering Wood difficult of combustion and preserving it underground:—The wood, unplaned, is to be placed for 24 hours in a liquid composed of one part of concentrated silicate of potassa and three of pure water. After being removed and dried for several days, the wood is again to be soaked in this liquid, and after being again dried, painted over with a mixture of one part of cement and four parts of the above liquid. When the first coat of this paint is dry the painting is to be repeated twice. This paint mixture should only be made up in small quantities, as it rapidly becomes dry and hard. Wood thus treated becomes uninflammable, and does not decay underground.—*Chemical News.*

HOTHOUSE VENTILATION.

Mr. Ormson has exhibited to the Royal Horticultural Society at Oxford the model of an improved house, in which provision was made for winter Ventilation by arranging that the air should be duly warmed before its admission. The form of pipe employed is that of a hollow cylinder, possessing a heating surface equal to four 4-inch pipes, or more, if necessary. The external air is admitted through a tube, nicely adjusted to valves in the front wall, and connected to the interior of these cylinders, where, as a matter of course, it becomes rarified, and consequently forced out through openings provided in the cylinders into the house, by the denser air which is constantly pressing in. Such a stream of warmed air rushing into either a hothouse or apartment will keep the air of such places constantly moving, through the displacement of the cooler particles by the warmer, and *vice versâ*, so long as a portion can find escape; and this Mr. Ormson has provided for by hollow rafters having zinc panels, perforated on their lower side, and a valve at the top of each rafter communicating with the chamber shown at the top of the back wall, through which it escapes by iron gratings in the face of the wall above the glass roof. This plan of heating may be used in public and other buildings where large masses of people congregate together, as the vitiated air constantly passes away, and its place is supplied by fresh warmed air, which, unlike the cold draughts usually admitted by windows, would neither chill tender plants nor give cold to individuals. The hothouses themselves are rendered light in appearance by the use of very large glass of great thickness, and the plan of glazing is such that no putty is exposed to the destructive influence of the atmosphere.—*Builder.*

THE SEWAGE QUESTION.

The following papers have been read to the British Association:—Mr. J. Bailey Denton read a paper "On the Extent to which Existing Works and Practice militate against the Profitable Utilisation of Sewage." He pointed out that there were few instances in which irrigation and natural filtration had been associated; they were, however, sufficient to support the conclusion that no system of irrigation should be adopted in which filtration did not form a part of it. Mr. J. N. Shoolbred followed with a paper "On the Sewage of Liverpool and the Neighbourhood." His conclusions were that the district of Liverpool and its neighbourhood is favoured by nature with above the average amount of facilities—first, for the collection of its sewage by water carriage, and then in finding, at a comparatively short distance, an outlet in the river Mersey for the larger portion, which it deems advisable to get rid of in this manner. It was again fortunate in having an outlet which, at present at least, secures immunity to the town from the unpleasant consequences which sometimes arise from creating an acknowledged sewage nuisance. Should the town itself at any time prefer to derive some benefit out of this refuse which it now throws away, or should changes in the law, said to be shortly contemplated in regard to the disposal of town sewage, compel it to seek another method of disposing of this refuse, it might be seen that nature provided for this new want, and that the town of Liverpool possesses, at no excessive distance, a most suitable and extensive site for utilising its sewage by irrigation upon the land, with, at the same time, a certain market in itself for the vegetable produce of that irrigation. Mr. Hope (of the Sewage Farm, Barking), remarked that the Sewage Committee of this section were of opinion that there should be an Act of Parliament to prohibit the construction of sewers which were not made of impervious materials. Professor Reynolds showed that, as at Bedford, sewage could be applied to land without being a nuisance to the neighbourhood, provided that it was put upon the land before it had been many hours in the drains. Mr. Brierly, of Blackburn, expressed a confident opinion that sewage irrigation, under proper management, could be carried out successfully without the slightest nuisance, as at Carlisle, even in the immediate contiguity of dwellings. Professor Ansted condemned the sewerage works at Aldershott as a nuisance beyond all question. Mr. Rawlinson regretted to have to give a flat contradiction to a man so eminent as Professor Ansted; but the Professor had been telling this meeting what he defied him to substantiate, and had made a very gross mistake. The question of sewage irrigation would not be made better or worse by false advocacy. With regard to the irrigation carried on at Aldershott, if ever there was a success, or if we might ever hope to have a success in utilising sewage, without committing offence,—and he said it looking Professor Ansted straight in the face,—they must take Aldershott. Let Professor Ansted investigate it as he had done, and ascertain the facts. [illegible] had been his duty, on behalf of the Government, to investigate a complaint that the sewage farm at Aldershott was causing a nuisance. His Report had appeared in print. A portion of the sewage of Aldershott was devoted to the irrigation of land as bad as the world could produce,—as the Lincolnshire farmers said of the fens, "worth nowt an acre,"—and now that land let at 25*l*. an acre per annum. There was no nuisance, and there was a living vegetation. If fresh sewage were put into carriers having a putrid deposit, then there was fermentation and offensive effluvium. The gentlemen who discouraged sewage irrigation had not carried their investigations far enough. Professor Ansted read a note, which he had made at Aldershott, to prove his assertion. Mr. Hawksley replied at great length to Mr. Rawlinson, and asserted that Professor Ansted's assertion was "true in every word." At Aldershott the stench was abominable, and the land and vegetation were killed by over-saturation. The land had been let at 25*l*. a year; now the tenant paid no rent, and received a subsidy of several hundreds a year to occupy it for Government purposes. He deprecated "blue-bookism," and advocated the chemico-mechanical system for the disposal of sewage as the best.—We quote the preceding *précis* from the *Builder*.

LIGHTING MINES BY GAS.

At the Royal Institution of Cornwall, Mr. W. J. Henwood, the President, remarked that in Sweden at the beginning of this century, and in Himalaya some fifteen years ago, the miners obtained light (and were sometimes almost suffocated) when at their work by smoky flames from burning splinters of resinous pine. In Brazil, oil, expressed from nuts of the *Palma Christi*, is commonly used by the miners. An experiment made at Balleswidden, near Penzance, during several months of 1856–7, attracted at the time much less attention than might have been expected, and is now almost forgotten. Coal Gas was made on the surface, and conveyed down one of the shafts to a depth of more than 120 fathoms through a 2-in. wrought-iron pipe, from which, branches, varying from ¾ in. to 1 in. in diameter, were laid—in some cases for at least 170 fathoms—along the several (levels) galleries; and similar tubes extended, occasionally as much as 10 fathoms above the levels, to the various (backs or pitches) parts in progress. Flexible pipes of gutta percha were, on occasions, carried to individual labourers, but, where four men worked together, a single jet of gas gave light enough for them all. The captains of the mine reported that—"In the shafts, levels, and pitches, it answered so exceedingly well as to leave no doubt of it serving all the purposes for which it was intended." It was computed that the works were lighted by gas one-third cheaper than by candles.—*Mechanics' Magazine.*

A CITY LIGHTED BY NATURAL GAS.

The city of Erie, Pennsylvania, stands on the verge of the petroleum region. Natural Gas is formed in large quantities beneath the surface in this region, and it has been turned to account for illuminating purposes. On the night of October 26, the city of Erie was lighted by natural gas, obtained from a well sunk near the city gas-works. Thirteen gas-wells are said to be now in successful operation in Erie, and are mostly used to furnish fuel and light to factories. The gas is found at an average depth of 550 ft., and the yield per well is about 20,000 cubic ft. a day. The gas is said to require no purification, and is being introduced into private houses for fuel.—*Builder.*

GAS-LIGHTING POWER.

Professor Silliman informs us that the Illuminating Power of a jet of gas varies as the square of the quantity of gas burned, so that with twice the consumption of gas in a jet, we shall obtain four times the quantity of light. It has long been known that very small flames are deficient in illuminating power, as also are flames with which much atmospheric air has been mixed. But in gases rich in carbon a certain addition of atmospheric air is found to increase the illuminating power; and in ordinary gas the illuminating power will no doubt increase with the size of the burner up to a certain point. But the law will be different in gas which is rich in carbon from that which is found to hold in the gas from ordinary coal.

GAS PURIFICATION.

The referees appointed by the Board of Trade have been experimenting on the Purification of Gas, especially from sulphur. They state in a Report, that in regard to purifiers, as well as scrubbers, "the gas in some cases *was found to contain more sulphur when it left the "purifying" material than when it entered it!*" The italics and note of admiration are taken from the report. The addition to the impurity in one set of experiments (lasting a month) was at the rate of 34 per cent., and in another set (lasting an equal time) as much as 37 per cent. In another set of experiments, carried on at another gas-factory, the results were simply nil, the gas coming out as it went in. After the gas enters the gasometers, there are further intricacies. The water on which the gasholder floats absorbs sulphur, ammonia, and sulphuretted hydrogen from the gas. A hot shining sun on the exterior may so warm the metal as to vaporise the filmy coat, and the impurity which is evaporated then "goes off with the gas." Thus the gas will leave the holder in a worse state than it entered it, a fact which is known to occur sometimes, though the cause does not seem to have been distinctly apprehended. These curious investigations, and others of a like nature, are still pending. The referees have invented a new description of sulphur-

—*Builder.*

THE LARGEST GASWORKS IN THE WORLD.

Upon a tract of land about 150 acres in extent situated at Barking stand the largest and most perfect Gasworks in the world. These works belong to the Chartered Gas Company and are known as the Beckton Gasworks. The magnitude of the works will be apparent when we state that 1,000 tons of coal per day will be distilled in the retorts. The whole of the works stand upon an elevated plateau raised from the surrounding land to the level of Trinity high water. The coals will be landed on a curved pier carried on iron piles, which stretches out into the river for 400 ft. from the face of the river-wall, and then turns with a curve of 150 ft. radius, and gives an additional length of 385 ft. The pier is laid with rails to a 4 ft. 8½ in. gauge, which are divided off into five branches of viaduct from the river-wall. Two of these branches run through the retort houses on either side of the beds of retorts, where the coals will be dropped, the empty waggons being run to the rear of the retort houses and returned to the pier by a central line of rails laid between the houses. Six steam cranes, three on either side of the pier near the head, will unload the coal from the vessels into the waggons, which will be worked by two locomotives. There are four retort houses, each 360 ft. long, and 90 ft. wide; each house contains 30 benches of 18-in. clay retorts, nine retorts being set in each bed. The two chimneys connected with the retort covers are each 100 ft. high, and each rests upon a mass of concrete 17 ft. 6 in. square carried down to the level of the main foundations. The coal stores are 770 ft. long and 120 ft. wide, and occupy a central position between the retort houses. A narrow space on each side of the viaduct, having a stowage capacity of 30,000 tons, will be covered in, the remaining space being used for the passage of waggons.

The purifiers and scrubbers occupy two buildings to the right and left of the retort houses. These buildings are 250 ft. square, and each house contains 24 purifiers, each 25 ft. in diameter. There are 10 scrubbers in each house 20 ft. diameter and 30 ft. high. In front of the purifying houses are placed on the one side a boiler house 52 ft. by 33 ft., a meter house 80 ft. by 34 ft., engines and exhausters occupying a frontage of 80 ft., and offices and store-rooms 80 ft. long. Facing the other purifying house is a boiler house 50 ft. by 40 ft., a meter house 80 ft. by 60 ft., an engine and exhauster house corresponding to that on the other side, and a canteen for the use of the men. In the rear of these buildings are sheds, 350 ft. long by 100 ft. deep, for the manufacture and storage of sulphate of ammonia, grinding mills, general stores, and workshops. To the left of the premises are four gasholders, each 180 ft. diameter and 40 ft. deep, with a storage capacity of 1,000,000 ft. each. The meters will each measure 100,000 ft. of gas per hour. All the gas will be passed through the governors into the mains, and can be tested at will previous to distribution by means of two check purifiers, which are erected for the purpose of ascertaining the existence of any impurities that may have escaped through the purifiers in the course of manufacture. The gas will be conveyed to the city of London through 8 miles of 48-in. pipes, from whence it will be conducted to Westminster through 3 miles of 36-in. pipes. To the rear of the works a private road 60 ft. wide and 3 miles in length runs to Barking and beneath this road are laid the 48-in. mains. The works, when completed, will form the largest establishment of its class in the world, producing 10,000,000 cubic feet of gas per day.—*Mechanics' Magazine.* The gas was first conveyed as above Dec. 7, 1870.

METROPOLITAN GAS SUPPLY.

THE accounts for 1869 of the 13 Gas Companies by which the metropolis is lighted have been published, in compliance with the several Gas Acts, and "presented pursuant to Act of Parliament." The authorised capital of the thirteen companies is about ten millions and a half sterling. The largest amounts, as regards authorised capital, are those of the Imperial Gaslight and Coke Company, 2,860,000*l.*, of which 1,153,653*l.* remain to be issued and called up; and the Gaslight and Coke Company, 2,012,500*l.*, of which 708,464*l.* remain to be called up and paid. The quantity of gas sold to consumers during this year is very nearly, if not quite, 9,000,000,000 cubic feet, and the aggregate amount received by the companies for public lighting and for lighting by contract, 222,000*l.* The companies have taken during the year about 1,250,000 tons of coal. The price at which four-fifths of the gas are supplied is 4*s.*, the remainder being cannel gas, at 5*s.* 6*d.* per 1,000 cubic feet, and the supplies by the South Metropolitan Company at 3*s.* 2*d.* and 3*s.* 4*d.*, and by the Independent Gas Company at 3*s.* 4*d.* The receipts appear to have been ample to enable the companies to pay the maximum dividend of 10 per cent. upon their ordinary stock.

THE MEAT QUESTION.

IN the *Food Journal* an interesting article appears on the Meat Question of 1870, in which is discussed the different means propounded for bringing to this country from cheap sources abroad an abundant supply of beef, mutton, and other meat which may be sold with profit at a low price. In Australia the mutton yielded by the extensive sheep farms in that country is for the most part boiled down for tallow; and a sheep of the average weight of 50 lb. produces, when thus treated, about 23 lb. of tallow, which leaves, when sold in London, after paying expenses, a return of about 5*s.* 6*d.* There is much of the carcass, however, which yields very little tallow, but which would be valuable for food if it could be brought to this country; and one of the most important problems of the day is how meat may be brought from distant sources without deterioration in the quality and without serious expense. One method which promises well is to melt the fat parts of the carcass into tallow and to enclose the lean parts in a net bag of such a size as nearly to fill a hogshead, and to immerse this bag in a cauldron of hot tallow for a sufficient time to expel the moisture and air from the pores of the meat. The whole mass is then to be suspended in a hogshead and melted tallow poured around it, whereby the meat will be hermetically sealed. There are six processes, however, for preserving meat in its transport from foreign countries which are at present in use, and which are—first, that of extract; second, tinning; third, curing; fourth, chemical preparation; fifth, freezing; and, sixth, transportation of live cattle.

All these methods may be usefully employed. By the use of properly-fitted steamers, there is every reason to believe that the transportation of live cattle from the River Plate may be successfully effected; and, if so, an enormous trade could hardly fail to grow up, as the sources of supply on the one hand, and of consumption on the other, are of such vast extent as to be practically inexhaustible. The extract of meat is an article that is coming into extensive use, as is also partially-cooked meat preserved in tins. But it is necessary to the success of the movement that the main part of the supply should come to us in joints or carcasses, and there are many plans proposed for the attainment of this end. One method is to expose the meat to the action of sulphurous acid, and afterwards to dry it in an atmosphere of 140 deg., so that the albumen may be desiccated, but not coagulated. But by this procedure the meat loses some of its flavour. Professor Gamgee proposes to kill the animal after having first rendered it insensible by carbonic oxide, and the joints are then placed in a chamber containing a mixture of charcoal and sulphurous acid, and into which a current of air mixed with carbonic oxide, and artificially cooled, is blown. The freezing processes of Harrison, Carré, Siebe, Kirk, and others have been tried to preserve the meat by the maintenance of a low temperature; and recently Mr. Reece has been enabled, by the continuous distillation of ammonia, to produce thirty tons of ice with one ton of coals, consumed in the engine by which the apparatus is worked. Mr. Postle proposes to fit up a ship for the reception of the carcasses, and to keep them sweet by circulating air among them cooled down to within one or two degrees of the freezing-point. On the whole, it may be expected that, with the attention which is now being given to this subject, and with the issues at stake, means will soon be discovered for bringing large supplies of good meat from distant parts of the world at a moderate cost.—*Illustrated London News.*

At the first sale of Australian meat, at the Hop and Malt Exchange, in Southwark Street, the quantity of meat submitted was 100 tons, consisting chiefly of mutton, cured in carcass, hind-quarters, hams, and rolls, packed in pure fat, which realised from 3½*d.* to 6*d.* per lb.; barrels of sheep's tongues, packed in pure fat, realised 8*d.* per lb.; 1,000 smoked sheep's tongues realised from 1*s.* to 1*s.* 2*d.* per dozen, and 300 smoked ox tongues averaged from 1*s.* 1*d.* to 1*s.* 2*d.* each; 60 cases of mutton, in tins of 7 lb. each, fetched 6½*d.* per lb. Of the many forms in which Australian meat has been introduced for consumption in this country, that which has been found most generally satisfactory is the cooked mutton. This meat is positively a delicacy, eaten either cold or warm. The only point necessary to be borne in mind, when serving the meat in the form of stew, is to thoroughly cook the vegetables and other ingredients before adding the meat. As one pound of the Australian cooked meat is equal to a pound and a half of uncooked butcher's meat, and as it is sold for 7*d.* or 7½*d.* per lb., the economy in using this article of food is considerable.

VESSELS OR APPARATUS FOR PRESERVING FOOD.

THIS invention chiefly refers to the employment of charcoal in Vessels for Preserving Meat and other Food; also to means of establishing a flow of atmospheric air through the vessel, in the manner hereafter described. The charcoal is placed between the outer casing of the vessel and a lining or inner casing; the inner casing is perforated for the preserving properties of the charcoal to pass through, and, in order that the meat or other food placed in the vessel may not come in contact with the perforated sides of the inner casing, a second perforated casing is employed a short distance from the other one. It is preferable to make the bottom of it of only one sheet of metal non-perforated, and to turn the edges up to form a tray for holding any water or liquid that may fall upon it; above this a perforated false bottom is fitted, upon which the meat may be placed. Trays or shelves may be fitted or slid into the vessel and rested upon supports or rails in any suitable manner. The upper part of the vessel is formed of corrugated ribs or rails, into the recesses of which bottles or other articles may be placed for cooling; above this vessel is another vessel, the bottom of which is formed of a corrugated plate, and which rests upon the rails before mentioned; each of the corrugations or recesses corresponds with the recesses in the rail. In the upper vessel and upon the corrugated plate ice or other cooling medium may be placed, which throws off its cooling properties into the first-named vessel, and acts upon the meat placed therein. Apertures are formed in the sides or ends of the first-mentioned vessel, and when the door or doors are opened shutters or valves move upon centres or otherwise and cover the openings up; but when the doors are closed the valves are removed and leave the apertures open for the passage of atmospheric air to act upon the charcoal placed inside. A shield is fixed near each aperture to break up and distribute the air over the entire mass of charcoal. The doors are made in a similar manner to the vessel. A cistern is arranged to some part of the vessel for containing water for drinking purposes; this water is kept cold by the action of the ice.—See *Mechanics' Magazine*, April 20.

MEAL AND MEAT EXTRACT FOR LIQUID FOOD.

MESSRS. H. M. WHITEHEAD & Co., of Lime-Street Square, London, have patented the means for preparing Blocks of Meal and Extract of Meat for making Liquid Food, such as soup. The blocks are intended to contain one ounce of solid extract of meat of any kind, and about two ounces of prepared flour; these are thoroughly mixed and compressed by hydraulic power into a suitable shape for packing. One block is sufficient for making a pint of strong soup; it has only to be put into water and boiled for a few seconds, when it is ready to be consumed.

The extract of meat is obtained from Messrs. Whitehead's establishment at Broadwater, Clarence River, New South Wales, and it is mixed with the meal and compressed into blocks in this country. The advantage of this kind of food to the poorer classes of the community will be much appreciated in the cold winter months. The smallness of the cost per block, and the facility of having a good wholesome basin of nutritious food in a short time, will ensure a large demand for it immediately the cold weather sets in.—*Mechanics' Magazine.*

PRESERVED BREAD.

PRESERVED Bread has been suggested by M. Maurice as a substitute for biscuits for the use of sailors, soldiers, and travellers. The bread is made in the ordinary way, and is then thoroughly dried. It is afterwards exposed to high-pressure steam for a short time, and is subsequently submitted to hydraulic pressure to reduce the bulk. The cakes so produced will keep, it is said, for years, if protected from moisture. They are necessarily hard, but are masticated as easily as biscuits. The process by which these cakes are made is long and troublesome, and the only advantage that they can possess over biscuits consists in the circumstance that they have undergone the primary fermentation which some writers on dietetics allege is absolutely necessary to produce bread of a perfectly wholesome character. —*Mechanics' Magazine.*

NEW TYPE-SETTING AND DISTRIBUTING MACHINE.

A NEW Machine has been patented by Mr. Mackie, the proprietor of the *Warrington Guardian*, for Composing and Distributing Types. There are in fact two machines—one like a small piano, whereby strips of paper are perforated by working keys. In this way the literary matter is prepared for the composing or type-setting machine, the perforations guiding the deposit of the types, which is done by the other machine. "Justification" is done as usual, by hand. The reverse process of distribution is also done by the machine. A well-composed and printed page of matter done in this way has been sent us for inspection. Authors may prepare their own perforated slips and send them to the printer in place of "copy." Six perforators and six composers could set up a *Times* page in an hour. The *Engineer* gives an engraving of the larger machine, and speaks highly of its ingenuity and its practical accuracy.—*Builder.*

THE PRINTING ROLLER.

The Composite Roller now in use by printers was the chance discovery of one Edward Dyas, printer and parish clerk of Madely, in Shropshire. His glue-pot having been upset, and Dyas not having a pelt-ball ready at hand, he took up a piece of the glue in a soft state, and inked a form with it so satisfactorily that he continued its use. He afterwards added treacle to keep the glue soft.—(*Mechanics' Magazine.*) To this we may add that somewhat more than 50 years since, the writer, while standing beside a Stanhope printing press, suggested the substitution of a roller for the balls, to roll over the whole form at one sweep; but he had not in view the composition for coating the roller.—Ed. *Year-Book of Facts.*

WATERPROOF PACKING PAPER.

Waterproof Packing Paper, according to the *Stationer*, is thus made by some manufacturers:—"The paper must first be covered with a resinous liquid, then painted over with a solution of glue and soot, as without this the paper will later show blotches. After this is dried the actual waterproof coat is applied. This is prepared with 2½ oz. of powdered shellac, dissolved in two pints of water, which is gradually brought to boil, and stirred until the substance is perfectly dissolved and softened, when gradually one-third of an ounce of powdered borax is added, until an intimate union of the substances takes place. The liquid is then left to cool, and, while still hot, any mineral colour may be added, such as lampblack, yellow ochre, red ochre, iron blue, or burnt umber, whereupon it is left to get entirely cold. It is then ready for use. The operation can be so quickly performed with a brush that two women can prepare 3,000 ft. in 10 hours."

MILNER'S SAFES AND THE BRITISH ASSOCIATION.

We have received particulars of some experiments made with Messrs. Thomas Milner & Son's Fire and Thief Resisting Safes, at the Phœnix Safe Works, Liverpool. The results of the tests appear satisfactory in every way. In the first instance an ordinary cast-iron safe, without any fire-resisting chambers, and one of Messrs. Milner's ordinary fire-resisting safes, of the weakest quality, were tested in a large fire composed of coal and wood, the result being, after two hours and a half, that the former was entirely destroyed, while the latter remained intact, a 100*l.* note and a large number of circulars which were placed in its interior being wholly untouched. In a second test, one of Messrs. Milner's safes, containing a 100*l.* note, several gold watches, and a number of circulars, was consigned to a terrific fire, in which it remained for five hours and a quarter without any effect of the flames—save a dulness in the colour of the iron—being visible, while the contents were perfectly unharmed.—*Builder.*

NEW CEMENTS.

Mixtures of litharge and glycerine are being used and strongly recommended in Paris. The lead is mixed with more or less of the ordinary glycerine of commerce, according to the purpose to which it is to be applied, whether as a lute cement or dressing. These cements are applicable to all the metals and to apparatus and machinery of all kinds; resist water and more than 500 deg. of heat. When required for luting, the litharge and glycerine should be intimately blended either by the muller or palette knife, the glycerine being added gradually until of the requisite consistency. The joints or other parts to which the cement or lute is to be applied must be carefully cleaned and afterwards dressed with a little glycerine alone; the cement must be applied as soon as made. These compositions are said to resist not only the action of steam, water, and concentrated or other acids, but also alkalines, ethers, alcohol, sulphite of carbon, benzoline, and all the hydrocarbons. For this purpose the mixture must be made of the consistency of ordinary paint, and applied in the same manner.—*Mechanics' Magazine.*

STRAIGHTENING A CHIMNEY.

It is stated that the furnace-chimney at the Goole Alum Company's works having subsided to the extent of 4 ft. out of perpendicular, was thus set right:—A layer of bricks, about two-thirds of the way round, and about 20 ft. from the base, was cut out. When this layer of bricks had been taken out, strong iron wedges were introduced, and a thin layer of brick put in the place of the course of bricks extracted. When this had been accomplished, the wedges were then drawn out, and the stupendous structure came over on to the new-made bed, assuming its original position. This was a dangerous process, and needed clear heads.—*Builder.*

THERMO-PLASTIC PUTTY.

In a paper read before the Civil and Mechanical Engineers Society, by Mr. R. M. Bancroft, on the renewal of King's Cross station roof, it was stated the glazing putty used in this roof was that known as Thermo-plastic Putty, and manufactured by Sir W. A. Rose & Co., Upper Thames Street. It is peculiarly adapted for fixing the glass in roofs of railway stations, green-

houses, and other buildings where plate-glass and iron sash bars are used. This putty hardens in a few hours after being used, but will, when exposed to solar heat, sufficient to cause expansion of the glass and metal, become plastic, and on cooling, again returns to its original firmness, thus preventing the loss by fractures and leakage which occurs so frequently in places where the ordinary glaziers' putty is employed.

MANUFACTURE OF WHITE LEAD IN AMERICA.

It is estimated that at least 40,000 tons of White Lead were produced in the United States last year, and of this fully one-third by four establishments in Brooklyn. The largest corroding works in the country are in this city. It is further estimated that about 700 tons of lead in oil were imported in 1869, and about 1,500 tons dry. The amount of pig lead consumed in the United States the same year was over 30,000 tons, nearly all of which, as we have stated, is imported. The actual capital invested in the corroding business alone cannot be much less than 30,000,000 dols., and fully 5,000 hands are regularly employed. If we look at the business incidental thereto, such as grinding, colour-making, and selling, the proportions of this industry are vastly enlarged.—*Builder.*

TIN-LINED LEAD PIPES.

THE patent of Mr. Haines, of Liverpool, is thus described in the local *Daily Post* :—Mr. Haines's patent may be simply described as a Lead-Encased Block Tin Pipe, which it is found resists all corrosive influences. It is now being manufactured in considerable quantities. We had an opportunity of visiting the factory and of witnessing the process of manufacture, which, however, with one single and most important exception, is the same as that adopted in the production of the ordinary lead piping. The exception is in the casting of the ingot. The molten lead is first poured into a mould, in which, by the insertion of an iron bar, a space is left for the tin. When the lead has cooled the bar is removed, and a mandril of the exact width which the pipe is to take is inserted. Around this again the molten tin is poured, and when the mass has cooled it goes through the usual process until it emerges in the form of a pipe. . . . . The engineer to the Glasgow Corporation works has tested the piping with reference to its cohesive power, and has reported that it has on an average of three tested thicknesses a cohesive strength double that of the ordinary lead pipe. The result of the experiments at the Liverpool waterworks on May 5 last was even more encouraging. Three thicknesses of the ordinary lead piping tested had an average cohesive strength of 2,840 lb., while the lead-encased tin pipe showed an average cohesive strength of 6,481 lb.—*Ibid.*

TALKING MACHINE.

At the Palais Royal, Argyll Street, has been exhibited a Talking Machine, which by mechanical appliances is made to give forth utterances resembling those of a human being. It is the invention of Professor Faber, of Vienna, and was constructed and patented by him, and is certainly a wonderful specimen of human ingenuity. It is true, the question may arise, Where is the utility of it, seeing that every man, woman, and child possesses a talking machine, more or less perfect, of his or her own? But the machine has its utility, nevertheless, for it illustrates a much neglected science of acoustics. Moreover, it is highly interesting as showing how far ingenuity may go. The machine has a mouth, with tongue and lips, which are set in motion by a mechanical apparatus which sets free a portion of air from a large bellows, and so controls it as to produce the sound required. It pronounces, with great clearness, every letter of the alphabet, many words, and a few sentences perfectly; not merely set words, but any words the audience chose to name. It also laughs, and utters other cries expressive of human passions, to the astonishment, apparently, of every one who hears it.—(*Mechanics' Magazine.*) (See the description of Prof. Faber's Speaking Machine, *Stories of Inventors and Discoverers*, p. 51, 1860, by the Editor of the present *Year-Book.*)

NEW CARVING MACHINE.

In the machine invented by Mr. Gear, of Newhaven, U.S., the wood to be carved is fastened firmly to the bed by movable clamps adjustable to suit any required size of wood, and the cutters are fastened to a spindle moved by a universal joint in any direction upon the bed of the machine. The cutter is guided by hand, the guide resting against the pattern. The carving can be gauged to any required depth, and made to conform to any required pattern. A fan blows away chips as fast as they are produced, leaving the work constantly in view of the operator. The same tool which cuts the mortise also cuts the tenon, the two pieces of work to be dovetailed being clamped together to the end of the table. Every kind of finish hitherto made upon the edges of lumber, and which has hitherto been mitred and glued upon the face to create a finish, is planed, beaded, and moulded upon the piece itself by this machine.—*Builder.*

PAPER MADE FROM WOOD.

Paper has been made entirely from wood, at least equal in colour and texture to the cheaper kinds of ordinary printing paper. There is no doubt that the pulp from the fibre of the fir and some other kinds of wood makes excellent material for paper, which can be prepared at a low price, the only practical difficulty being the high temperature, and consequently the high pressure, required to decompose the non-fibrous matter. Another material now actually employed for the manufacture of paper is the husk and seeds of the cotton-pod, from which the oil has been expressed; the fibrous pulp resulting from this operation is said to be an excellent paper-making material. The larger portion of the cheaper printing papers used for newspapers, magazines, &c., is now made entirely from the Spanish esparto grass, a name given to two distinct species, *Mecrochoa tenacissima* and *Lygeum spartum*, both growing abundantly on the shores of the Mediterranean; but the comparatively high price of this material, more than double what it was a few years since, affords a favourable opening for the introduction of other paper-making fibres.

TO DYE HORN BLACK.

According to C. Burnitz, of Stuttgart, Horn may be Dyed Black by a cold process in the following way:—The horn is first to be soaked in a solution of caustic potash or soda, until the surface is a little dissolved, and feels greasy. Then the article is to be washed and treated with Lucas's aniline black, after which it is to be slowly dried and again washed. By exercising a little care, we read that combs with fine teeth may be dyed in this way. The articles look of a dark brown colour by transmitted light, but seen by reflected light they are deep black.—*Mechanics' Magazine.*

GOLD LACQUER.

The gold-lacquer lining of a Chinese cabinet in the Museum at Cassel peeled off, and thus gave Dr. Wiederhold the opportunity of studying the composition of this substance. On examining it he found particles of tinfoil attached to the lacquer; so he comes to the conclusions that this material formed the ground upon which the lacquer varnish was laid. His attempts to imitate the vanish were perfectly successful, and he gives the following directions for the preparation of a composition which closely resembles the true Chinese article:—First of all, two parts of copal and one of shellac are to be melted together to form a perfectly fluid mixture; then two parts of good boiled oil, made hot, are to be added; the vessel is then to be removed from the fire, and ten parts of oil of turpentine are to be gradually added. To give colour, the addition is made of solution in turpentine of gum gutta for yellow, and dragons' blood for red. These are to be mixed in sufficient quantity to give the shades desired.

JAPANESE ENAMELS.

The great attraction at Mr. Bickersteth's *soirée* at the Philharmonic Hall at Liverpool, in the week of the British Association meeting there, was a display of Japanese enamels, kindly lent and arranged for the occasion by Mr. J. L. Bowes. Even the comparatively coarse Chinese imitations are rare, and command high prices; but the genuine Japanese work seems to be not only unknown to European collectors, but to be unknown even to those who have lived in the country and studied its art. There are but three specimens in the South Kensington Museum, and the manufacture is not even referred to in Siebold's great work on Japan. Mr. Bowes believes that enamelling may be a lost art, and that all the examples of it were in the royal palaces or in the palaces of the great Daimios. He conjectures that the palace of some Daimio may have been burnt, and his dispersed collection smuggled out of the country for sale by those into whose hands it fell. This conjecture is in some degree supported by the fact that many of the pieces in Mr. Bowes's collection bear the armorial insignia of a Daimio or of the Mikado himself. The collection consists of sixty-two pieces, and comprises a great variety of articles, large and small. There are vases, dishes, cups, plates, teapots, a kettle, and many other things, nearly every one of which must have been the result of a life of labour. The basis is in all cases of copper, and on this a pattern of exquisite fineness, and generally of much elegance, has been formed by soldering gold wire to the surface. Into the little cups or hollows thus made the enamel pastes have been deposited and then burnt in, and the surface finally polished to perfect smoothness. The dishes are enamelled in patterns on both sides, the cups and vases usually lined with plain enamel of a dark green colour. The designs are mostly floral or geometrical, with fishes, birds, dragons, and conventional clouds, and the drawing is not grotesque. The favourite ground colours are dark green and dark blue, but others are also used, and the patterns and objects are in all manners of bright tints. In some of the very finest specimens there is what resembles a Greek fretwork pattern. From this most imperfect description it is impossible to form any adequate idea of the beauty and fineness of the work, which must be seen and studied to be appreciated.—*Selected from the Times Report.*

BEER FININGS.

THE manufacture of a new material as a Substitute for Isinglass for Finings has been patented by Mr. J. C. Martin, of Barnes. His invention consists in obtaining from hide pieces, or skin cuttings (commonly known as glue pieces), a substance closely resembling, in the nature of its fibrous appearance and clarifying properties, the isinglass at present used for fining. In the ordinary method of making gelatine from glue pieces, the substance is reduced by dissolving in hot water. Mr. Martin, however, educes the hide pieces to a fibrous jelly by crushing and pounding, and subsequent treatment with acid solutions. The material selected is that which is most free from fat and flesh, &c. It is cut into strips about four inches long and a quarter of an inch wide. These pieces are then ground or reduced to a finely comminuted condition by machinery until they assume the condition of short fibrous pulp. In practice, Mr. Martin has found the best method to treat the material is a paper-maker's beating engine, the action being kept up until the material is ground quite fine. When it has assumed a condition resembling fine short paper pulp, it is removed from the trough of the engine to a tank, and treated with a solution of acetic acid of about the strength of ordinary vinegar. This acid solution is well stirred in, just enough being used to swell the small fibres and cause them to thicken and convert the pulp into a kind of fibrous jelly that will admit of thinning out with cold beer or water into the condition of ordinary beer finings. After the acid solution has been stirred in, the reduced material is to be placed in airtight vessels, and allowed to digest for some months, for although directly after the pulp is thickened with the acid solution it will clarify beer, its effects are found to be much improved by keeping or digesting.

WELL-BORING.

MIDDLESBROUGH-ON-TEES is about to make an addition to its mineral exports. It has sent forth millions of tons of coal, and now is opening a trade in the rock-salt which lies deep down below the foundations of the town and the alluvial deposits of the Tees. The salt exists in large beds, which were discovered by boring; and concerning this boring there is something interesting to be told. The apparatus used was that invented by Mather & Platt, of the Salford Ironworks, Manchester, in which the boring-tool is attached to a flat rope, and by percussive action loosens the earth or rock, when, giving place to a peculiar kind of bucket which fills itself, the fragments are drawn up. This alternation is continued till the required depth is reached. By the use of the rope the work is greatly facilitated, for everything can be raised or lowered with rapidity, thereby contrasting favourably with the slow progress that attends the use of iron rods. The boring at Middlesbrough, 1,312 ft. deep and 18 in. diameter, was accomplished in 540 days, including 150 days of stoppages, mostly for the purpose of pumping out and testing the water accumulated in the well. Deducting these, the sinking occupied not more than 390 days; and it is worth notice that the number of men employed never exceeded six. This must be regarded as but a moderate outlay for the discovery of great stores of salt and brine and the creation of a new industry.

Reckoning from the surface, the first 1,160 ft. of the boring passed through new red sandstone interspersed with beds of clay, white sandstone, red marl, and gypsum. Below this lay 40 ft. of gypsum, hard white sandstone, and limestone, succeeded by red sandstone, pure salt rock, occasional limestone, and then salt rock to the bottom.

To this account of a successful undertaking at one extremity of Yorkshire we may append a brief mention of a success at the other. Hull had for many years been afflicted with a bad water supply. An enterprising townsman had three contiguous borings made in the outskirts to a depth of 400 ft. through the clay, and now two million gallons of excellent water, bright and sparkling, rush up from the cool depths every day for the use and enjoyment of the inhabitants.

At a meeting of the Institution of Mechanical Engineers, Mr. Mather stated that a well was now being sunk, by the method above described, at Moscow, to a depth of 3,000 ft., in search of a water-supply; and that he had offered to "put down" a 4,000-ft. boring in Surrey, to explore for the beds of coal which, according to geological theories, lie deep below that county.

M. E. Lippman has communicated to the *Annales industrielles* an account of the operations for sinking the artesian well at La Chapelle. The engineers employed by the authorities of the city of Paris to execute this great work are MM. Degosée, Laurent, & Co. When completed, this well will supply water to one of the most populous quarters of Paris. It is intended that this well shall not only strike the water-bearing stratum—at a depth of about 2,000 ft.—into which the great well at Passy penetrates, but shall extend through the stratum to a total depth of 2,950 ft. In this way, other water-bearing layers will be intersected. The work was at first commenced by the ordinary method of sinking a masonry shaft 2 mètres (6 ft. 3¾ in.) in diameter to a depth of 445 ft. through the tertiary strata which lie above the chalk. Many difficulties presented themselves, chiefly due to the looseness of the earth through which the excavation penetrated, and to the insufficient pumping power. After two years of persistent labour, it was decided to try another system. At this period the shaft had reached a depth of 113 ft.; new boring machinery, driven by steam power, was now set up, and until the present time the work has proceeded most satisfactorily.

A late Number of *Cosmos* refers to a method of increasing the produce of wells which was exhibited at Paris in 1867, but which does not yet seem to be widely known. By this system the top of the well is made close, and the pump which lifts the water also partially exhausts the air. The effect of this arrangement is to suck in the water from the circumjacent strata, whereby the yield of the well is considerably increased. Pipe wells like those used in the Abyssinian expedition, when properly constructed, will have the same operation; and in India and other tropical climates such wells or pumps will yield much better water than open wells, in which the water is allowed to stagnate. They have also the great recommendation of being much cheaper.

THE TOWER SUBWAY.

It is now about 28 years since Brunel's great work, the Thames Tunnel, was completed. It was commenced in 1825, and occupied seventeen years. Its cost was 1,200*l.* per lineal yard. The Tower Subway has been completed in fewer months than its predecessor took years, and at a cost of about three times as many pounds as its great prototype took hundreds.

The Subway consists of a narrow tunnel uniting two vertical shafts, one being on Tower Hill, and the other in Vine Street, Tooley Street. The tunnel is lined with iron tubing, bolted together in short lengths by means of flanges projecting on the internal surface. The placing and fixing of the portions of the tube were effected within a shield or bell, which was constantly pushed on before the advancing work; and the conception has been seized upon by Mr. Bateman as the basis of his well-known suggestion for a submarine tube to carry a railway from England to France. The Thames tube is 7 ft. in clear internal diameter, or 6 ft. 8 in. between the flanges, and it carries a railway of 2 ft. 6 in. gauge. On this railway runs an omnibus capable of conveying 12 passengers. The tube is about a quarter of a mile in length, and sinks from both ends towards the centre with a gradient of about 1 in 30. The omnibus is of iron, light, but very strong, and runs upon eight wheels. It is connected with a rope of steel wire by means of a gripe that can be tightened or relaxed at pleasure, and at each end of the tunnel this wire runs over a drum worked by a stationary engine. The declivity of the tunnel is such that, when once the omnibus is started, it requires only a small amount of traction, and the momentum acquired during its descent will carry it a long way up the opposite slope. It is said that the strain on the rope will never exceed 2 cwt., and the rope used, although very slender in appearance, is capable of bearing more than a ton. The omnibus is provided with breaks, so that its motion is completely under the control of the man in charge; and at each end of the tunnel it is received by buffers, or rather catches, that are connected with very strong springs of vulcanised india-rubber. The shafts at each end of the tunnel are 60 ft. in depth, and are lined partly with brickwork and partly with iron tubing. Within these shafts there are lifts, capable of carrying six passengers at once, and these lifts are raised and lowered by the same engines that work the drums. Each lift has a counterpoise equal to its own weight, and to that of three average passengers, so that the weight of three passengers represents the *maximum* of work that will be demanded from the engine, either for raising or lowering. At the top of each lift is a very ingenious contrivance by which a breakage of the suspending chain would close iron claws upon the lateral guiding rails, and would bring the machine to a standstill in the course of a few feet. At collieries, where the miners are raised and lowered in a cage, it sometimes happens that they are carried over the wheel at the top; but the ascent of these lifts is checked by springs of steel and india-rubber, which the engine employed would not be strong enough to break. The wheel over which the suspending chain runs is also dragged, so to speak, by revolving fans, and too great rapidity of either ascent or descent seems to be rendered practically impossible.

The arrangements visible from the world above are almost ostentatious in their simplicity. The upper opening of each shaft is covered by a tiny square building, like a slightly exaggerated sentry-box. At the door stands an official, provided with a book of tickets and a pouch for money. As they pay passengers enter the box and descend in the lift. On reaching the bottom they find a space of a few feet between the shaft and the buffers fitted up with benches, as a waiting-room. When the omnibus arrives, and has disgorged its load, those who are waiting will step in, and will start off immediately for the other end. The descent of the shaft occupies 25 seconds, and the omnibus journey 70 seconds, so that a passenger may sink into the earth at Tower Hill and emerge in Vine Street in a minute and three-quarters from the time of his disappearance. Allowing for all ordinary causes of detention, such as missing the lift at the moment of its descent, or being just too late for the omnibus, the journey from point to point cannot occupy more than five minutes. The lifts, as they only carry half as many passengers as the omnibus, will make twice as many journeys, and it is intended to give priority of ascent to first-class passengers, who will pay 2*d.* for that privilege. Second-class passengers will pay 1*d.*

The most extraordinary part of the whole undertaking has been its cheapness. The capital of the company amounts only to 18,000*l.*; and the plant would provide for a traffic which would repay this capital in a single year.—*Abridged from the Times.*

THE INSTITUTION OF CIVIL ENGINEERS.

THE council of the Institution of Civil Engineers have awarded the following premiums :—

1. A Telford Medal, and a Telford Premium, in books, to E. Dobson, for paper on "The Public Works of the Province of Canterbury, New Zealand."

2. A Watt Medal, and a Telford Premium, in books, to R. Price Williams, for paper on "The Maintenance and Renewal of Railway Rolling Stock."

3. A Watt Medal, and a Telford Premium, in books, to J. Thornhill Harrison, for paper on "The Statistics of Railway Income and Expenditure."

4. A Telford Medal, and a Telford Premium, in books, to T. Sopwith, jun., for paper on "The Dressing of Lead Ores."

5. A Telford Medal, and a Telford Premium, in books,

to J. Nicholas Douglass, for paper on "The Wolf Rock Lighthouse."

6. A Watt Medal, and a Telford Premium, in books, to G. Berkeley, for "Observations on the Strength of Iron and Steel, and on the Design of Parts of Structures which consist of those Materials."

7. A Watt Medal, and a Telford Premium, in books, to R. Briggs, of Philadelphia, U.S., for paper on "The Condition and the Limits which govern the Proportions of Rotary Fans."

8. A Watt Medal, and a Telford Premium, in books, to E. A. Cowper, for paper on "Recent Improvements in Regenerative Hot Blast Stoves for Blast Furnaces."

9. A Telford Premium, in books, to John Grantham, for paper on "Ocean Steam Navigation."

10. A Telford Premium, in books, to D. Makinson Fox, for "Description of the Line and Works of the Sao Paulo Railway in the Empire of Brazil."

11. The Manby Premium, in books, to Emerson Bainbridge, for paper on "Coal-mining in Deep Workings."

The council have likewise awarded prizes to students of the institution for papers.

BRICKMAKING MACHINERY.

We are accustomed to both hearing of and seeing new and improved machinery for Brickmaking, but we are not accustomed to either hear of or see anything but the old material, clay, used for making bricks. Our German friends are ahead of us in this line, as it appears that they make bricks from coke, which are reported as being light and durable, and adopted for fence walling, and if they are as good as represented, they would do capitally for inside work and various other purposes where common bricks are used. The following is the description given by M. O. Wagner of making bricks with coke and lime:—He employs from 10 to 12 parts of coke as it comes from the retorts; and after breaking them up until no piece remains more than 2 in. in any way, he then adds one part of fresh burnt lime, which is spread over the coke and slaked with water until all is moist. The whole is then passed through a pug mill, and afterwards left untouched for a day or two to allow of its becoming dry enough to pass through the brickmaking machine. The bricks when made are left to dry on boards for some days, when the surfaces are dressed. He recommends the drying to be effected in warm weather in the shade. The bricks may be used within a week or a fortnight after they are made, and a wall built of them is said to become more solid every day. On this system the thickness of the brick may be augumented without inconvenience, and from 3 in. to 4 in. is a common thickness. Such bricks make a light and very dry wall, and are fit for fencing purposes.—*Builders' Trade Circular.*

At the new Patent Brick Works, established by Mr. D. W. Barker, on the canal side at Worcester, the red marl found in that locality is, with the aid of powerful grinding apparatus, readily converted into good sound bricks. Twenty-four bricks are made in a minute, according to the local *Herald*. The marl is cast into a grinding-mill, and, when fit, receives there a certain quantity of water. Converted into a soft, well-amalgamated mass, it is then conveyed to the press, where it is moulded and pressed. A creeper receives the soft bricks at this stage, and carries them direct to the top of the kiln, where the hand touches them for the first time. The bricks are then removed from the creeper, placed in barrows, and stacked in the drying-sheds erected at the top of the building, in order that the waste heat may be utilised in the first process of drying. In that way the heat from the burning bricks beneath dries the green ones, until they are ready for the hot chambers below. The machinery in use is driven by a compact engine.

Extensive works for the manufacture of bricks have just been completed by Major Stapylton, of Myton Hall, Helperby. To insure making more solid bricks than by hand, and doing away with skilled labour, he has introduced machinery driven by steam-power, which enables him to produce bricks with smooth surfaces like the "patent bricks." This is all done in one operation. After the clay is cast in the ordinary way it is put into wagons, and by means of a rope connected with the machine it is hauled up a tramway and tipped on to the rollers, which crush all foreign matter, such as stones, and thence enters the pug-mill, where it is thoroughly incorporated and made ready to enter the dies, from which it passes to the two cutting-tables, on each of which are cut at once six bricks.

Those bricks which are wanted for very particular purposes, such as facing, are passed through a special machine,—"the rotary press,"—which performs its work of pressing, and thereby consolidating the bricks. A brick is simply placed in front of the piston, which then forces it into the mould or die (of which there are four on a revolving shaft) of the desired size, and any superfluous clay is cut off, thus making all the bricks true and of uniform dimensions. During the return of the piston, the box of dies or moulds revolves one-fourth of the way round, thus presenting another empty mould, which has already been oiled and cleaned by a self-acting lubricator, directly opposite the piston, to receive the next brick. In the meantime a self-acting push-plate forces the brick already pressed out of the die, upon a self-acting table, which carries them away, each brick being impressed with the initials of the proprietor. Both the machines described are driven by a horizontal engine, and are the productions of Mr. John Whitehead, of Preston, Lancashire.

ASPHALT PAVEMENT.

The carriage ways of two of the most important thoroughfares in the city of London—namely, Cheapside and the Poultry—have been paved with compressed asphalt under the supervision and at the expense of the Commission of Sewers. The work is undertaken merely by way of an experiment, and the thoroughfares in question were selected by Mr. Haywood, the engineer of the Corporation, as being the most suitable for the complete testing of the durability and other alleged qualities of the pavement. The asphalt is supplied by the Val de Travers Company, and has previously been used in the paving of a small portion of Threadneedle-street, where the carriage traffic is comparatively light.

The pavement is formed in the following manner, according to the statement of the engineer:—A foundation is first made of Portland cement concrete, 8 in. thick, on the top of which a coating of mastic about ½ in. in thickness is run and worked to the proper slopes and curvatures The asphalt is laid on this foundation. It is brought from Switzerland. and is entirely composed of the natural rock ground to a powder, and subjected in that state to great heat in a revolving boiler on the spot. After this it is taken out, laid over the surface, and, while in its heated state, compressed with burning irons into one homogeneous mass, without joints and impervious to moisture. The asphalt is about 2 in. thick, and when finished presents a wonderfully smooth and level surface. The cost is about 18*s.* per square yard, including the foundation, and 1*s.* 6*d.* per square yard is the annual expense of keeping it in repair. It is stated that at the end of eight or ten years the pavement will be in as good a condition as when first laid, and that the rapidity with which repairs can be effected will tend much to the public convenience. The principal advantages possessed by it over ordinary pavements are that the traction of vehicles is much reduced, and consequently passengers in carriages are less jolted, and the fatigue of horses is diminished; that it is impervious to moisture, and very noiseless, and that it can be easily and effectively cleansed. On the other hand, it is unsuitable to streets having sharp gradients, and in some rare instances it will be more slippery than the usual granite carriage ways. The Commission has been induced to make the experiment partly in consideration of the successful application of asphalt in the streets of Paris, and partly on the suggestion of a large number of firms in the City, and of the residents in the streets in question. There can be no doubt that the pavement will receive a trial amply sufficient to test it in every possible way. On the question of durability and cost there is no experience in England. At Paris it was more expensive than granite, but nevertheless more than 15 miles of street were there laid with it. If the Company's prices were stated at the lowest, it would, Mr. Haywood thought, be dearer than granite pavement in London. It had been found in Paris cheaper than macadamized roads, but there was not such good material there for forming the surface as in London. It was probable, however, that it would be quite as cheap in streets of considerable traffic, and that, with proper management, it would give the convenience without the disadvantages of macadam. Upon the whole Mr. Haywood thought the compressed asphalt pavements could be formed as expeditiously, and with as little public inconvenience, as those of granite; that the repairs generally would be more difficult and expensive, but that mere surface repairs made in fitting weather would be more perfect and complete than those of stone pavements.

"PETRIFIED CONCRETE."

Some works have recently been established in the neighbourhood of Victoria Park for the manufacture of artificial stone by a new process. The *Pharmaceutical Journal* says:—" It has been known for some time that Portland cement, or any concrete containing lime, can be rendered extremely hard by immersion in a solution of silicate of soda. Under these circumstances, the silica is absorbed by the lime, and the cement thereby converted into a true stone. But the cost of the silicate of soda has hitherto rendered such a process too expensive for general application. The proprietor of the works we refer to has overcome this obstacle in a most ingenious manner. Beneath the chalk beds of Surrey, in the neighbourhood of Farnham, there exists a plentiful deposit of a soft stone, containing 25 per cent. of silica, in a condition in which it is soluble in a cold solution of caustic soda. This material the inventor grinds up and diffuses through the bath of silicate of soda, containing the concrete to be petrified. The lime, removing silica from the solution, liberates caustic soda, which dissolves fresh silica from the Farnham stone. The process thus becomes a continuous one. The soda acts as a carrier of silica from the stone to the cement. By due care, the solution of silicate of soda may be maintained of constant strength, and is therefore capable of performing an almost indefinite amount of work. The expense of the silicate of soda being once defrayed, the cost of 'petrifying' the concrete is simply the value of the Farnham stone and the labour of applying it. No heat is required in any part of the process, and the work is therefore very simple."

A NEW OMNIBUS FOR MELBOURNE.

The great principle involved is the carriage of the load below the centre of gravity. The new style of conveyance has been patented by Mr. Dyer. Instead of the passengers being inside the vehicle, as at present, they are all outside of it. There is no close box into which twelve human beings are stuffed to inhale each other's expirations and exhalations. There is no crushing up for a seat, or putting seven in a space intended for six, and not too large for five. All inconveniences are avoided by placing the passengers back to back, instead of face to face. The new omnibus has only one hind wheel, instead of two; and this one wheel, placed in the centre of the vehicle, does the work of the two now used. A light and elegant roof covers the two rows of seats, and reaches down in front far enough to shelter the passengers from rain or sun, but not far enough to obstruct their view of the opposite side of the street in which they are going. There are aprons also which draw up from the foot-board, as a protection in wet weather. The vehicle is therefore much lower than the present omnibus, being only about 8 ft. in height. A passenger steps in and out at one effort from the street into his or her own separate place or division. The large wheel at the back is quite concealed, and revolves in a closed case or sheath, some 12 in. in width. The seats being on two sides and the end, and being comfortably padded at the back and cushioned, the vehicle will somewhat resemble that piece of furniture known as an ottoman, with arms to it and a roof overhead. There will be an immense economy in construction, as there are no doors, no glazing, no painting of sides, no internal panelling, and only three wheels instead of four. The draught on the horses will be much lighter, as the friction will be diminished by one-fourth at least. In addition to this, it is known that a wheel of large diameter is much easier to draw than one of small, so that there is no doubt but that the draught will be very much lessened. The weight of the vehicle will not be more than two-thirds of the present one, and the cost also.—*Builder*.

EXHIBITION AT SYDNEY.

The New South Wales and Victoria Intercolonial Exhibition at Sydney, opened by the Governor, Lord Belmore, on August 30, for one month, was held under the auspices of the Agricultural Society there. It took place in the Prince Alfred Park, where a handsome and commodious pavilion has been erected, at a cost of 23,000*l*., by the municipal corporation of the city, to be permanently occupied, at a yearly rent, by the Agricultural Society. The non-agricultural portion of the contents of the Exhibition, including works of art, such as pictures, furniture, and carriages; specimens of the woollen, iron, tallow, and other manufactures, and of the minerals of South-East Australia, was displayed in the building; while the cattle-show, with the sheds, stalls, and pens for horses and oxen, sheep and pigs, and the agricultural implements, covered three acres of the park. Among the animals were some very fine ones, especially the males imported from England for breeding, which were sold at high prices; the common price for a yearling bull of good race was 100*l*., and one three years old fetched 350*l*. The agricultural machines were all from Melbourne. We may notice, in connection with this subject, that the *Sydney Morning Herald* of September 7, published in a special supplement of eight large pages, gives a very complete historical and statistical account of the progress of New South Wales. It presents an interesting view of the rapid advance in wealth, industry, social comfort, and refinement which our fellow-Englishmen at the antipodes have achieved during two or three generations; while the various attractions and advantages of this fine colony are described with perfect truth.—*Illustrated London News.*

BUOYS FOR NIGHT SERVICE.

"One of the greatest impediments to navigation is darkness in buoyed waters. If it were possible to develop a lighting power in the buoys, this difficulty would be greatly diminished." So writes Mr. F. W. Van Eeden, general secretary of the Netherlands Society for the Promotion of Industry, at Haarlem, in a printed circular, in which the Society offer 300 florins in money, and a gold medal worth 150 florins, "for the most practical means of investing Buoys with a Lighting power, for service at night." The meaning of this is obviously some method by which buoys floating in rivers and estuaries, or on shoals at sea, shall light themselves up at nightfall. The thing is possible; but can it be reduced to easy practice? Particulars and plans are to be forwarded to the secretary before the end of September, 1871; but he states, among the conditions, that "the Society takes no responsibility for eventual damage to models or instruments, and reserves to itself the right of not returning them to the competitors."

GAS FIRES AND STOVES.

Mr. J. O. N. Rutter, of Black Rock, Brighton, gives the following, with other particulars, as to useful forms of Gas Fires and Gas Stoves. The gas fire consists of pumice (usually called pumice-stone), broken into tolerably small pieces, packed together to the height of the bars in an ordinary fire-grate, and heated to incandescence by gas. The pumice being carefully arranged, and the gas properly applied, in a few minutes there will be a brilliant fire. Here will be nothing to disturb our old-fashioned notions and susceptibilities about the cheering effects of an open fire,—a fire which can be seen as well as felt. The cost of materials and workmanship is very trifling—only a few shillings; but the cost of keeping up the fire is greater than that of a coal fire. Taking the cost of a coal fire at ½d. per hour, that of a gas fire will be about 1⅛ of a penny. This must be taken into consideration when estimating the advantages of a gas fire. The pumice rapidly gets into a glow, and is nearly indestructible, without dust or other nuisance, and the fire gives good heat and can be diminished or increased at will. Mr. Rutter also thus describes a gas stove:—

"During the last twelve winters I have had the enjoyment of a stove which is isolated as respects the room in which it is fixed. The air which supplies the means of combustion to the gas-jets is conveyed from out-of-doors, underneath the floor, and through the bottom of the stove; and the exit-flue communicates with the chimney of an adjoining room. The perfection of warming by gas is thus attained. Any required temperature can be maintained without varying one degree for any required period. . . . A room which has no chimney, nor one near enough to be available, can be effectually and healthfully warmed; and a room with a chimney, but useless by reason of down-draught, may be made as comfortable as any other in the house."

With such a chimney a gas fire does not do well.—*Builder.*

Professor Rogers has made a communication to the British Association on the influence of carbonic acid and air in diminishing the illuminating power of Coal Gas. His results differ considerably from those obtained by some other experimenters, and it may be that they are not very reliable, but we give them for what they are worth. One per cent. of carbonic acid, according to the professor, reduces the illuminating power from 6 to 8 per cent.; but further additions do not produce proportional reductions. Air causes a greater reduction of illuminating power than carbonic acid; 10 per cent. of air reducing the power 70 per cent., while the same proportion of carbonic acid only causes a reduction of 40 per cent. We may refer here to the results of Messrs. Silliman and Wurtz. published in these columns last year. These gentlemen state that 12 per cent. of air destroys only 40 per cent. of illuminating power. It is right to say, however, that Professor Rogers' results come near to those of Andouin and Berard, who say that 6 per cent. of air destroys half the illuminating power of gas, or perhaps we ought to say of Paris gas—a poor gas; and 20 per cent. of air destroys all the illuminating power. According to Professor Rogers it takes 45 per cent. of air to destroy all light, and it takes 58 per cent. of carbonic acid to effect the same result. We have hinted that these experiments may not be worth much, but the results may be perfectly accurate for the particular gas and burner employed by the author.—*Mechanics' Magazine.*

THE NEW OZOKERIT CANDLES.

These beautiful Candles have been patented by Messrs. Field and Siemssen; the invention consisting of a new material to the production of illuminating oils and solid hydro-carbons, suitable for the manufacture of candles and other purposes. The word Ozokerit is derived from the Greek Ozo (I smell of) and keros (wax), and is thus described in Dr. Ure's *Dictionary of Arts* (edition 1853):—"Wax, mineral, or *Ozocerite*, is a solid, of a brown colour, of various shades, translucent, and fusible like bees' wax; slightly bituminous to the smell, of a foliated texture, a conchoidal fracture, but wanting tenacity, so that it can be pulverised in a mortar. Its specific gravity varies from 0·900 to 0·953. Candles have been made of it in Moldavia, which give a tolerable light. It occurs at the foot of the Carpathians, near Slanik, beneath a bed of bituminous slate clay, in masses of from 80 lb. to 100 lb. weight. Layers of brown amber are found in the neighbourhood. It is associated with variegated sandstone, rock salt, and beds of coal (lignite ?). It is analogous to *hatchetine*. Something similar has been discovered in a 'trouble' at Urpeth Colliery, near Newcastle, 60 fathoms beneath the surface. *Ozocerite* consists of different hydro-carburetted compounds associated together; the whole being composed, ultimately, of — hydrogen 14, carbon 86, very nearly." (See also Dana's *Chemistry* and Watts's *Chemistry.*)

The word "Ozokerit" has been bestowed upon a mineral which is now exciting great interest. No doubt the natives of Russian-Poland have known it to possess light-giving properties, and the candles made from the crude material must certainly be offensive. The pure ozokerit, however, is colourless, and emits a finer and more brilliant light than any other substance yet used in the manufacture of candles. Sub-products of this mineral yield a material possessing greater insulating powers than almost any other substance, and promise to be of great importance in electro-magnetic apparatus. The patentees state: "We distil the raw material by fire-heat alone, or by superheated steam and fire-heat, either consecutively or combined, thereby obtaining an oilish distillate, the solid and liquid constituent parts of which are separated by pressure. The pressed solid material is then purified by mixing and stirring by sulphuric acid, when melted; after standing for some time, in order to effect its complete separation from the acid, the supernatant melted material is carefully drenched, and thoroughly washed with hot water. The water having been removed, the material is repeatedly filtered through animal charcoal until the requisite degree of whiteness is attained. Or, in place of the above process, the material is repeatedly mixed with naphtha and pressed; the small portion of naphtha remaining in the pressed cake is removed by the introduction of free steam until no more odour is perceptible, the only portions which have been removed by pressure are acidified with sulphuric acid, are redistilled, and treated with alkaline ley."

In the candle-making process the cakes of ozokerit are melted, and the candles cast in the same way as paraffin. The greatest advantages claimed for these candles is their high melting-point, which ranges from 140° to 143° Fahr., and the dry and wax-like character of the material; they burn with a large, white, and powerful flame, and do not accumulate, in the cup surrounding the wick, a large quantity of liquid material. In appearance they are beautiful, and come out of the moulds with a brilliant surface. The trade in paraffin candles has been much retarded because their great beauty is not available for the ball-room, as the great heat causes them to droop. For purposes of export, ozokerit is as useful as wax or stearine, cheaper than the former, and handsomer than the latter.

NEW TUNNEL-CUTTING MACHINE.

Among the objects of interest exhibited at the concluding *soirée* of the British Association at Liverpool, the most important was a mechanical contrivance by M. Tehebicheff, a Russian mathematician, for converting vertical into rotatory motion. The apparatus, as exhibited, consisted of a section of a piston and cylinder, and a system of arms and cranks connected with the piston rod set a wheel on a horizontal axis revolving in either direction as the piston was raised and depressed. The defect of the arrangement seemed to be that it had two dead points, from which it could not be started by the piston alone, but only by a slight movement of the wheel; and its most remarkable feature was that it was purely a result of mathematical calculation, and as such had existed on paper before it took shape in iron. Another chief centre of attraction was a working model of the tunnelling machine of Mr. J. D. Brunton. The original is now engaged in cutting experimental tunnels into the gray chalk near Snodland, the work there done being intended to serve as a basis for contracts for the projected submarine railway tunnel that is to connect England with France. The machine consists essentially of a horizontal axis, at the end of which is carried a cross-bar, revolving in a vertical plane, and having a circular chuck at each extremity. Each chuck carries six cutters, each of which may be roughly likened to a large quoit. These cutters are set somewhat obliquely to the vertical plane, and are free to revolve on their own axis; the effect of which revolution, combined with the general revolution of the chucks, is to give a sort of drawing cut by each quoit against the strata to be perforated. The amount of penetration is governed by the pitch of a screw on the main axis, and the speed of revolution by the two factors of the power employed and of the hardness of the material to be perforated. In the gray chalk of Snodland, which is believed to be identical with that of the ground to be pierced beneath the Channel, the rate of speed is about nine yards per hour for a drift way seven feet in diameter; and it is calculated that such a drift way might be cut from near Dover to Cape Grisnez in about 12 months, and at an expense almost nominal when compared with the magnitude of the work. The chief difficulty, indeed, would be the conveying away of the rapidly accumulating *débris*; and Mr. Brunton has of late been devising and testing several contrivances for the rapid delivery, behind the machine, of the chips that it cuts away. Independently of its probable use in an international undertaking that must at some future time be accomplished, the machine is already coming into use as a means of rapidly and cheaply cutting colliery and mining tunnels.

GREAT TUNNEL THROUGH THE ALPS.

PROFESSOR ANSTED has read to the British Association a paper, the joint production of himself and Professor King, entitled "Notes of a Recent Visit to the Great Tunnel through the Alps, and on several points of geological interest suggested by the condition of the works in the present nearly complete state." Diagrams were employed in describing the points of geological interest in the strata through which the tunnel is cut, and specimens of the rock were also exhibited. The tunnel, as Professor Ansted reminded the audience, will perforate the crest of the main chain of the Alps, nearly midway between Mont Tabor and Mont Cenis, passing nearly under the summit of Mont Frejus. The operations of the tunnel involve a direct cut through a series of rocks on a line whose depth below the surface was almost at once very considerable. Owing to the form of the ground and the rise of the mountain, the depth was 2,000 ft. at each end after 2,000 ft. of tunnelling. From this point, however, the depth increased very little from each end for a long distance. In the middle of the tunnel the depth below the surface is 5,400 ft., while the deepest borings for such works as mines and wells do not exceed 3,000 ft. The works have been carried on throughout with some regard to the great physical questions involved. Among these the temperature at various distances and depths beneath the surface was not the least important. Instructions were given to bore a large hole laterally into the rock for a distance of about 10 ft., at intervals of 500 metres, and determine the temperature of the rock by thermometers provided for the purpose. On the northern side this important experiment had been carelessly executed, but on the south side, especially towards the centre, some good observations had been made, and the result was somewhat startling. The last observation made at the time of his visit was at 6,200 metres (20,342 ft. from the south end), at a depth of more than 5,000 ft. The result was 28° C. = 80⅓° F. This would reduce the increment to a degree Fahrenheit in more than 100 ft., the general increase being observed in mines to average a degree in about 60 ft. Here again, however, there was still something wanting, the mean annual temperature of the surface not being accurately known, and the depth from the surface of the stratum of permanent temperature never having been determined. With reference to the progress of the work of tunnelling, the Professor stated that, on the 31st of last month, there remained less than 2,000 ft. out of 40,000 ft. to pierce; and, as the present rate of progress is about 500 ft. per month, it may be expected that the communication will be complete by the commencement of the ensuing year.

ADDIS'S SINGLE RAIL TRAMWAY.

THIS very ingenious arrangement of Tramway and vehicle is the invention of Mr. W. J. Addis, C.E., of Tanna, Bombay. We have here an Indian bullock cart of peculiar construction, loaded with three tons, and drawn with ease by two of the little country bullocks, equal each to about half a pony-power. The principle involved is excessively simple. A tramway is laid with a single rail, and on this are run vehicles of all kinds, fitted with two bearing wheels, which take all, or nearly all, the weight; and ordinary wheels, which hardly serve to steady the machine, and prevent overturning.

The advantages are that the cost of the tramway and the cost of haulage is reduced absolutely to a minimum. The plan is to lay down the rails at the sides of roads, one for up traffic, and the other for down traffic, leaving the centre part of the road for ordinary traffic; and as the rails are only 1½ in. or 2 in. above the surface of the road they would scarcely interfere at all with the ordinary traffic. On any road where there is a very large traffic bullocks could be dispensed with, and traction engines could pass along the line with trains of waggons. The cost of tramway will be Rs. 4,000 or Rs. 5,000 per mile.

Mr. Addis has laid down a length of rail in the grounds of his ironworks at Tanna, upon which he has placed two carts or wagons specially constructed by him for the tramway. A portion of the rail is laid at an incline of 1 in 40, and another portion, on level ground, describes a 10 ft. radius curve. This experimental line has been visited by a large number of gentlemen, government officials, and others, who have seen with satisfaction the ease with which a pair of bullocks draw 3 tons along the tramway. The flanged centre wheels are attached to a screw, by which the framework of the cart is raised, so that on level ground the ordinary side wheels may be 1 in. or 2 in. above the surface of the road, and the entire weight of the burden may rest on the rail. The side wheels of course occasionally touch the ground, but really the weight is borne by the centre wheels. In some experiments, tried recently, a large log of wood was placed on the ground over which one of the side wheels would pass, and the wagon put into rapid motion; on passing over the log the jerk was severe, but failed to throw the wagon off the rail. A small hole was then dug in the line of a side wheel, and over this also the wheel passed without accident.

The utility of the invention has already been recognised by several public officers, and a line has been laid down between Callian Bunder and Callian, a distance of 1¼ mile, over which there is a large salt traffic. Then shortly a double line will be commenced between Mhyjee station of the G. I. P. Railway and the ground on which the Mhyjee fair is held, a distance of about 3½ miles. There will thus be about 7 miles of rail to lay, and though this line will pass over a ready-made road, it is astonishing to hear that the laying of the entire length will require but little more than a fortnight.—*Engineer.*

THE ERECTION OF GIRDERS.

THE ERECTION or placing *in situ* of large and heavy Girders, constituting the principal components in a constructive sense of a railway bridge, is a problem that admits of but two solutions. One is to erect a temporary support for the permanent structure until it is in a fit condition to dispense with such adventitious assistance; the other, to reject all such subsidiary aid, and place the girders in position at a single operation. Notwithstanding that railways are now carried into districts and localities that at one time would have been regarded as inaccessible to the locomotive, and, consequently, the difficulties attending the erection of the permanent works have been considerably enhanced, yet we have not been compelled to wait until the present to learn how those difficulties may be overcome without the use of centering or scaffolding of any kind whatever. In the old days of bridge building, when the arch was considered the only existing type of strength and reliability, the employment of center was looked upon as indispensable, and it is therefore but natural that the same means should have been resorted to, although the type or style of construction has undergone very material modification. But it was not long before the Britannia bridge furnished an example of bridge building in which, for various insurmountable reasons, it was not possible to have recourse to the ordinary staging and centering upon which to construct the girders and their accessories.—*Engineer.*

UTILISING COAL WASTE.

THE enterprise of a Company in New York in utilising the refuse of coal mines, the accretions of which have been enormous, and hitherto valueless, has proved a complete success; buildings and machinery have been erected at Mauch Chunk. The fuel as prepared from the coal dust is said to be superior to the natural coal, burning without cinder or impurity of any kind. The Secretary of the Navy after testing the fuel has entered into a contract for all the present works are capable of turning out. The fuel, as supplied the Government, is in cubes of 5 in. From the regularity of shape, great advantage can be had in stowage, while the absence of cinder and, comparatively, of ashes renders it peculiarly desirable. The price is said to be lower considerably than that of coal in its present form. The supply of the refuse is inexhaustible, and this improvement gives us another advantage over the impracticable miners, who may strike at will if we can but utilise the dust which we have above ground by millions of tons. As a process has been lately ventilated by which coal has been ground to a fine dust, and carried by blowers into the furnace with sufficient air to produce immediate combustion and with the most eminent success, we suggest the use of the dust already on hand for similar treatment, not doubting equal results will be obtained.—*Iron Age.*

Natural Philosophy.

THE SCIENTIFIC USE OF THE IMAGINATION.

PROF. TYNDALL, in his lecture, delivered to the British Association at Liverpool, on The Use of the Imagination in Scientific Inquiry, maintained that though the detailed analysis might be, and might ever remain, beyond us, general results might be attainable. At all events, it was plain that, beyond the present outposts of microscopic inquiry, lay an immense field for the exercise of the imagination. Life was present potentially in matter when in the nebulous form, and was unfolded from it by the way of natural development, or it is a principle inserted into matter at a later date. The present inquiry regarding the introduction of life was: Does it belong to what we call matter, or is it an independent principle inserted into matter at some suitable epoch—say when the physical conditions became such as to permit of the development of life? There were the strongest grounds for believing that, during a certain period of its history, the earth was not fit to be the theatre of life. Whether this was ever a nebulous period, or merely a molten period, did not much matter; and, if we reverted to the nebulous condition, it was because the probabilities were really on its side. The question was this:—Did creative energy pause until the nebulous matter had condensed, until the earth had been detached, until the solar fire had so far withdrawn from the earth's vicinity as to permit a crust to gather round the planet? Did it wait until the air was isolated, until the seas were formed; until evaporation, condensation, and the descent of rain had begun; until the eroding forces of the atmosphere had weathered and decomposed the molten rocks, so as to form soils, until the sun's rays had become so tempered by distance and waste as to be chemically fit for the decomposition necessary to vegetable life? These questions defined a hypothesis not without its difficulties, but the dignity of which was demonstrated by the nobleness of the men whom it sustained. Modern scientific thought was called upon to decide between this hypothesis and another; but they might rest secure that the hypothesis just sketched could never be stormed, and that it was sure, if it yielded at all, to yield to a prolonged siege. However the convictions of individuals here and there might be influenced, the process must be slow and secular which commended the rival hypothesis of natural evolution to the public mind. The evolution hypothesis was not to be flouted away contemptuously or denounced as wicked. Let us not fear it, but steady ourselves upon faith in the ultimate triumph of truth; for under the fierce light of scientific inquiry it would certainly be dissipated if it possessed not a core of truth. Its existence as a hypothesis in the mind was quite compatible with the simultaneous existence of all the virtues to which the term Christian has been applied. It did not solve, nor profess to solve, the ultimate mystery of this universe; in fact, it left that mystery untouched. "Two things," said Immanuel Kant, "fill me with awe—the starry heavens and the sense of moral responsibility in man." And in his hours of health and strength and sanity, when the stroke of action had ceased and the pause of reflection had set in, the scientific investigator found himself overshadowed by the same awe. Breaking contact with the hampering details of earth, it associated him with a power which gave fulness and tone to his existence, but which he could neither analyse nor comprehend.

SPONTANEOUS GENERATION.

THE solution of this problem seems to be as far off as ever. It was much discussed at the late meeting of the British Association at Liverpool, and evidence given of living things found which must have either borne high temperature never before heard of, or they must have been evolved *de novo*. "If we had," says the *Gardeners' Chronicle*, "to select among our foremost naturalists one who more than any other might have been expected to uphold the doctrine of spontaneous generation, that one would have been Professor Huxley. But, like a doughty man of science that he is, he will not be led astray by personal predilections, but boldly and unhesitatingly draws inferences from the evidence before him—inferences wholly unfavourable to a doctrine which, from what he has said on former occasions, we assume he would gladly support did he feel himself at liberty to do so. The point in dispute, we need hardly say, is as to whether what we call living matter is, under all circumstances, as it certainly is under most, the direct product of pre-existing living matter, or whether it may not occasionally be generated *de novo* from a combination of elements under conditions as yet unknown to us? Happily we can at the present day discuss these matters without fear of pains and penalties, and without uncharitable assumptions or aspersions. In whatever mode the new life appears, the miracle of its production remains the same—the attributes of divinity are wholly unshaken."

THE ENTOZOA EGG—SPONTANEOUS GENERATION.

IN the course of the discussion which followed the reading of a paper on "Spontaneous Generation," to the British Association at Liverpool, an opinion was expressed that the Entozoa Egg, even if deposited in the root of a plant, could not be found in the leaves. Professor Huxley remarked that there was necessity for great caution in drawing conclusions upon this subject. It would certainly be an extraordinary circumstance if the egg could creep from roots to foliage; but what had not been taken into account was the extraordinary changes of form which the insects which lived in cattle were capable of undergoing. It was not simply the egg that had to be dealt with, but the egg *plus* a number of stages and conditions which made it capable of living in different circumstances from the parasitic worm. In illustration of this he mentioned the disease called the "staggers" in sheep. These were caused by the presence of a large endozoon developed in the brain of the sheep, which became a bladder-like substance, and ultimately caused death by apoplexy. The history of that creature was one of the most astonishing in the world. The abominable animal existed in other conditions. If they took the brain of a sheep which had died of this disease and fed a dog with it, it would eat it with great rapidity and delight, not being aware of the percentage it had to pay. The dog took in the bladder worm, which in his stomach became metamorphosed—it became a tapeworm, developed rapidly, and gave rise to joints containing the ova of the creature, which it never would do in the brain of the sheep, and eventually it was passed out with the refuse of the dog, and scattered upon the pastures on which the sheep were feeding. Some of the insects would be dispersed, but some would remain, and it was certain that by one or other of these channels the ova got back to the sheep. They then took a different course, and bored through the alimentary canal, were carried to the brain by the circulation of the blood, and there gave rise to the staggers. So that it was found the best way of keeping the staggers under was to look very sharp after the dogs.

PROTOPLASM.

Dr. Child has laid before the British Association certain propositions in regard to Protoplasm, simply as defining what he meant by it. Protoplasm was, as a rule, a more or less viscous fluid, consisting mainly of four elements—oxygen, hydrogen, carbon, and nitrogen—such as constituted the living portion of every organism, animal or vegetable We were unable by any process to discriminate between the protoplasm of the lowest plants and that of the highest animal; but, as a matter of fact, the protoplasm of one kind of organism so far differed from another as to conform to peculiarities of type. The earliest discoverable state of every organism was that of a simple minute mass of protoplasm, and beyond this stage many organisms never progressed. Vegetable organisms were capable of assimilating to their protoplasm certain inorganic compounds, but the animal world had to find its nutriment ready made in the vegetable kingdom. After an examination of the various germ theories which had been put forward, it appeared to him that abiogenesis in some form or another was a necessary consequence of certain other theories which were gaining ground at the present moment. It was hardly conceivable that we could theoretically hold the original simple forms, from which the whole animal and vegetable world had been developed, had sprung into existence out of the regular order of the evolution of the universe. What was called the germ theory of disease threw an interesting light on the question. Zymotic diseases were now generally believed to result from the multiplication and reproduction of germs in the blood of the man or animal affected. The matter to be accounted for was how the germ diseases appeared, disappeared, and afterwards again cropped up in the same district and at great intervals of time. If the old theories were to be maintained in their entirety as to the fixity of species, every one of these diseases must have existed somewhere from the beginning. That was a view which was hardly credible, but it was held nevertheless.

Dr. Lionel Beale's recent disquisition on "Protoplasm; or Matter, Force, and Life," does little to terminate the controversy which has long been raging between the vitalists, who assert the existence of a special vital force in living matter, and the physicists, who ascribe all vital phenomena to the action of known physical forces. Of the latter faith, Professor Huxley is the most prominent apostle; and certainly he has succeeded in showing that many of the forces heretofore regarded as vital and beyond our means of investigation were merely forces which can be produced in the laboratory by ordinary physical agents. Dr. Beale believes the constituents of a living body to be germinal or living matter; formative, or dead matter, and pabulum, or matter not yet assimilated or vitalised. But of the reality of this hypothesis, which we admit to be probable, he gives no proofs; and, as a general rule, he is much more lavish of assertion than of demonstration. Much of what is true of life is also true of combustion It is a process which does not begin of itself, but when begun continues by assimilating for its own purposes matter which would otherwise be inert. Finally, the combustion ceases from the accumulation of ashes, or of intervening particles, which hinder or impede the contact of the combining atoms. There may be strong vitality or weak, just as there may be intense or sluggish combustion; and the analogy may be extended to most of the vital phenomena.—*Illustrated London News.*

DESCENT OF GLACIERS.

THE REV. CANON MOSELEY has read at the Royal Institution a paper on this inquiry. He stated that glaciers do not originate in the highest Alpine regions, but from a wide belt girding them below, divided horizontally by the snow line, above which the snow always lies and the rain seldom falls, and beneath which the snow disappears every summer, and rain is abundant. From this belt the glaciers emerge, moving slowly, like huge slugs, along the descending valley, filling out the wide channels and contracting themselves in the narrow gorges. The slope of a principal glacier is often as little as 3 degrees, yet it may move 24 inches a day; while the motion of a tributary glacier may be only 4 or 5 inches, with a slope of 50 degrees. Glaciers carry on their back large pieces of rock and stones which when deposited form moraines, and their mass is composed of layers of white ice, separated from each other by layers of transparent ice, which is termed their "veined structure." The Canon then expounded at some length the various theories put forth to explain this veined structure and its relation to the descent of glaciers, including the "viscous theory," supported by Principal J. D. Forbes, and the "regelation theory," advocated by Professor Tyndall, illustrating his remarks by experiments upon the structural nature of ice. After expressing his own conviction that these theories are insufficient to account for the various phenomena, and asserting that weight cannot be the displacing force, because its work is less than that of the resistance, he attributed this force to solar heat. In support of this opinion he referred to the testimony of many Alpine travellers, from De Saussure to Forbes and Tyndall, respecting the great intensity of the solar radiation and its effects upon the surface of glaciers; and noticed the fact that the Mer de Glace moves faster by day than by night, and in summer than in winter. The sun, he said, is obviously "the master of the glacier." He next described a series of very delicate corroborative experiments made to observe the descending motions of a sheet of lead placed on an inclined board on the roof of Bristol Cathedral from February till June, by which he determined that the movement was very slight between sunrise and sunset, least upon days of continuous rain, and greatest on bright days with cold winds, the sun being the obvious cause of the descent of the lead: a dilatation and contraction of it were caused by the passage into it and withdrawal of the sun's radiant heat, and these made it descend. A succession of small alternations, he said in regard to glaciers, produce the same effect as great ones. In conclusion, after alluding to the valuable contributions to this subject given by the late William Hopkins, the Canon concluded by stating that, like him, he had laboured to bring the discussion of glacial phenomena out of the wide region of scientific opinion, and place it in that of exact science.—*Ibid.*

CURRENTS OF THE POLAR SEAS.

THE discrepancy in the action of the currents experienced in 1823 and 1869 on the extensive ice-fields which occupy the middle space between the coast of Europe and East Greenland is very noteworthy. In 1823 the most careful observations of officers greatly practised in such investigations failed to discover any perceptible surface-current whatsoever, either by its effect on the ice itself, or on the surface-water of the sea between the ice and the Greenland coast; whilst in 1869 the crew of the *Hansa* having taken refuge on the ice after the loss of their vessel in the approximate geographical position of 70° 50′ N. and 21° W., were carried by it to the lat. 61° 12′ and long. (about) 42° W., being a drift extending over more than 500 geographical miles, accomplished in little less than 200 days, the average being somewhat less than three miles a day. In seas much encumbered by floating ice, currents are generally due to the prevailing winds; and there appears to have been in 1869 a considerable amount of northerly gales. But the frequent existence of a current setting to the south and south-west down the coast of East Greenland has been recognised by the highest authorities; and is regarded by Forchhammer, in his valuable memoir on the Phenomena of the Sea, in the *Philosophical Transactions* for 1845, as a returning branch of the Gulf Stream, recognisable as such by the difference in the analysis of the polar and equatorial waters.—*President's Address to the Royal Society.*

OCEAN CURRENTS AND CHANGES OF CLIMATE.

In the March Number of the *Philosophical Magazine* is a valuable paper by Mr. Croll, on the Influence of Changes in Ocean Currents in producing Secular Changes of Climate. The Gulf Stream is a great warming apparatus, which heats the northern hemisphere; and if from any cause it were to be diverted into the southern hemisphere instead of into the northern, the effect would be to raise the temperature of the antarctic regions to a point considerably above the freezing-point, while the northern hemisphere would be correspondingly cooled, and would subside to a temperature such as must have prevailed during the glacial epoch. Mr. Croll consequently proposes the inquiry whether any cause is in existence which is likely in times past to have produced any large change in the direction of the ocean currents, and he finds such a cause to exist in the gradual change of eccentricity in the earth's orbit. With the eccentricity at its superior limit, and the winter occurring in aphelion, the earth would be about eight millions and a half miles further from the sun during that period than it is at present, which would have the effect of lowering the temperature of mid-winter about 46 deg. Much of the moisture which now falls as rain would then fall as snow, and the winters would be 36 days longer than the summers instead of 8 days shorter, as at present. The large accumulation of snow would cool the air, and occasion fogs, which would prevent the penetration of the sun's rays. If we suppose this state of things to occur in either hemisphere, then it can be shown that the Gulf Stream, or other great ocean currents, would concur in aggravating the effect. The trade winds are produced by the difference of temperature between the poles and the equator, and the greater this difference the stronger the winds will be. If one pole be colder than the other, the trades will blow stronger in one hemisphere than in the other, and the strongest winds will pass the medium line. At present, the southern hemisphere being somewhat the colder, the southern trades frequently blow 10 deg. or 15 deg. north latitude, while the northern trades seldom blow past or up to the equator. If, however, the northern hemisphere were the coldest, the northern trades would be the strongest; and if we suppose them to be very strong, they would deflect the Gulf Stream towards the Antarctic Ocean, and aggravate the cold by the loss of such a powerful heating agent. In the variations of eccentricity of the earth's orbit in long periods of time we have consequently an adequate cause of the successive glacial and tropical epochs which have alternated in each hemisphere, and which we know, from geological evidences, have in times past existed.

PENDULUM OBSERVATIONS IN INDIA.

During the past year Captain Edward Basevi has completed six sets of observations in connexion with the great Trigonometrical Survey of India, with pendulums and apparatus lent for the purpose by the Royal Society. No more observations on the line of the great arc are now required; but before sending the pendulums back to England Colonel Walker considers it desirable that observations should be taken on the highest accessible table-lands of the Himalayas as well as at various points on the coast line, and at the Calcutta and Madras Observatories. The observations already taken have an important scientific value, inasmuch as they tend to confirm the hypothesis, that the density of the strata of the earth's crust under the Himalayan Mountains is less than under the plains at a distance from those mountains. This hypothesis has been put forward by the astronomer royal and by Archdeacon Pratt of Calcutta, whose papers on the subject may be read in the *Philosophical Transactions*. He suggests that "below sea-beds the crust of the earth is as much denser, through a certain depth, as will equal the deficiency of matter caused by the ocean hollow; and beneath mountains the density is as much less, through a certain depth, as will account for the excess of mass in the mountains." If this be true, then, as the observations are carried from the interior towards the coast, they should indicate an increase in the force of gravity, just as they should indicate a decrease on approaching the mountains. Of course a crucial test would be a few observations on the very bed of the sea; but as this is impossible, the next best thing is a few observations along the coast. We are informed, too, that Captain Basevi will take observations on the low island of Minikoy, which stands on a coral reef in the ocean 250 miles from the mainland, and travel thence to complete his task on the Himalayas. Should the result confirm the hypothesis above mentioned, it will be in the estimation of all who cultivate physical science a most satisfactory termination to his arduous labours.—*President's Address to the Royal Society*; *Athenæum.*

THE EARTH'S ECCENTRICITY.

Mr. A. R. Wallace has exhibited to the British Association a diagram of the Earth's Eccentricity and the Precession of the Equinoxes, illustrating their relation to geological climates and the rate of organic change. The author deduced certain important views as to the climates of past geological ages and the changes of organic life. During the past three million years the eccentricity has been almost always much greater than at present, on the average twice as great, and for long periods more than three times as great. It was shown that when the eccentricity was greatest the heat received from the sun at the greatest and least distances was as 3 to 4; and, owing to the precession of the equinoxes, the winters of the northern hemisphere would be rendered intensely cold, and much longer for periods of 10,500 years, while during the alternate periods the winters would be mild and short, the summers cool and long, leading to an almost perpetual spring. We thus have cold or glacial epochs for about 10,000 years, alternating with mild epochs for the same period, whenever the eccentricity was high, and this was the case for fully half of the last three million years; and, as such alternations must have occurred during every glacial epoch, the fact of intercalated warm periods and the migrations consequent on them, which have been detected by geologists, must be looked upon as the normal condition of things. But during the last 60,000 years the eccentricity has been very small, and the alternations of climate and consequent migrations very slight; and, as Mr. Darwin holds that alternations of climate are, by means of the consequent migrations, the most powerful cause of modifications of species, there must have been a comparative stability of species during that time, from which alone we obtain our ideas of the rate of specific change. This idea will therefore be erroneous, and the rate of change during past geological ages may have been, and probably was, much more rapid than has hitherto been thought possible. During three million years before and one million after the recent epoch, no less than 130 changes of climate occurred (each of 10,000 years' duration) when the eccentricity was more than double what it is now; and these incessant changes were thought, on Darwinian principles, to supply a *vera causa* for a rapid change of species, and thus enable us considerably to reduce the duration of geologic periods, which had heretofore been measured by means of the period of organic stability since the last glacial epoch.

A FACT FOR GEODESISTS.

Sir Thomas Maclear, who has remeasured and extended Lacaille's arc of the meridian at the Cape of Good Hope, states that, "with respect to the contrivances for measuring base-lines, something is yet wanting to enable us to meet the enemy; that is, temperature on equal terms. I built (he says) two pillars of solid masonry, and sheltered them at a locality on the line. Each carried a micrometer microscope. With these I compared the relation between the expansion of the standard iron-bar and the indications of the two thermometers with oblong bulbs sunk in holes in the bar and surrounded with oil, and observed in the accidental temperature of the atmosphere, at short intervals, throughout twenty-four hours, night and day. The expansion of the bar in ascending temperatures, and contraction in descending temperatures, were about two hours behind the indications of the thermometer. To this circumstance is owing in part the rough results of comparisons in the field between the standard iron-bar and the compensation-bars."—*Athenæum.*

NORTHERN MAGNETIC POLE.

Mr. Proctor estimates that the Northern Magnetic Pole rotates round the north pole of the earth, from east to west, once in about 655 years. The southern magnetic pole rotates round the south pole of the earth in the same period, and the magnetic equator, though its inclination with the earth's equator remains nearly constant, yet its nodes must travel from east to west in the same period as the poles. Such a motion has actually been observed.—*Illustrated London News.*

NEW FIELD OF MAGNETIC RESEARCH.

Mr. F. H. Varley has exhibited to the British Association a Permanent Magnet, which displayed the action of magnetism upon the crystallisation of iron. The author referred to this fact as affording a means for the future investigation of magnetic phenomena, and also showed that dia-magnetic substances could be crystallised in magnet fields; and thus would define permanently the action of magnetism on the crystallisation of magnetic and dia-magnetic metals. He expressed his belief that from experiments commenced in the year 1858, and others conducted in 1870, electricity and magnetism conjoined would produce permanent magnetic structures, showing in a solid form the lines and nature of magnetic force.

MOVEMENT OF MATTER.

The following illustration, says Prof. Henry, of the vibratory Movement of Matter is attested by Prof. Horsford, of the United States. The top of the high tower which constitutes the Bunker Hill monument inclines towards the west in the morning, to the north at mid-day, and towards the east in the afternoon. These movements are due to the expanding influence of the sun, as it warms, in succession, the different sides of the structure. A similar but more marked effect is produced on the dome of the Capitol at Washington, as indicated by the apparent motion of the bob of a long plumb-line, fastened to the underside of the roof of the rotunda and extending to the pavement beneath. The bob describes daily an ellipsoidal curve, of which the longer diameter is four or five inches in length. By molecular actions of this kind, time, the slow but sure destroyer, levels with the ground the loftiest monuments of human pride.

THE PERPETUUM MOBILE.

THE search for Perpetual Motion is itself a perpetual motion: there is no putting a stop to it; they are still at it, and in long-headed Scotland too. A new invention by Mr. J. Millar, of Dalry, "consists of obtaining and transmitting motive power by a novel arrangement of mechanism, consisting of levers on which the motive force as weights or pressure acts through small toothed wheels, acting and rolling in and on the teeth of an internal rim, fixed or stationary disc or segment thereof;" and in an invention of Mr. J. S. Johnstone, of Ayr, "the mechanism consists, under one modification, of a series of weighted levers arranged in a framework, each lever being connected with a spring balance. By means of suitable mechanism the levers are raised in succession through a certain height, from which they are allowed to fall, and in falling they act upon the spring balance in such a way as to depress it; the surplus force above referred to is transmitted so as to lift or raise corresponding levers, and also to act upon stop-wheels for driving a revolving shaft." It is just the old story over again: the perpetual motion moves in a circle in more senses than one.—*Builder.*

Professor DE MORGAN thus vigorously defines the impossible problem of the Perpetual Motion:—"The purse of Fortunatus, which could always drop a penny out, though never a penny was put in, is a problem of the same kind. He who can construct this purse may construct a perpetual motion; in this way: Let him hang the purse upside down, and with the stream of pence which will flow out let him buy a strong steam-engine, and pay for keeping it at work day and night. Have a new steam-engine ready to be set in motion by the old one at its last gasp, and so on to all eternity. A perpetual motion demands of the nature of things a machine which shall always communicate momentum in the doing of some work, without ever being fed with any means of collecting momentum. It could be compassed in a certain way—that is, by retaining the work done to do more work, which again should do more, and so on—if friction and other resistances could be abolished, and nothing thrown away. In this way the fall of a ton of water from a reservoir might be employed in pumping up as much water into another reservoir, which, when landed, if it be lawful to say so of water, might, by its subsequent fall, pump up an equal quantity into the original reservoir, and so on backwards and forwards, in *secula seculorum.* But not a drop must be wasted, whether by adhesion to the reservoir, by evaporation, by splashing, or in any way whatever. Every drop that falls down must be made to raise another drop to the same height. So long as the sockets have friction, or the air resists, this is impossible. In fact, matter, with respect to momentum, has the known qualities of a basket with respect to eggs, butter, garden-stuff, &c. No more can come out than was put in; and every quantity taken out requires as much more to be put in before the original state is restored. So soon as the law of matter is as clearly known as the law of the basket, there is an end of looking for the Perpetual Motion." —*Athenæum.*

MOABITE STONE.

A PAPER on "The Relation of the Ancient Moabites to Neighbouring Nations, as disclosed in the newly-discovered Moabite Stone," has been read to the British Association by the Rev. C. D. Guisburg, LL.D. He said that the inscription on the stone read almost like a chapter in the Bible, and when it was borne in mind that this curious relic dated back 900 years before Christ, it would be seen that the inscription was older than two-thirds of the Old Testament. Out of 12 or 15 Moabite cities mentioned in the Old Testament, 11 were enumerated in the inscription. Respecting the relation of the ancient Moabites to neighbouring nations he had come to the conclusion that, at the period indicated, an organised temple service existed among Jews out of Palestine, and that the service must have been very much akin to the service of the Moabites; that 900 years before Christ the word Jehovah, which was afterwards so much avoided by the Jews, was so much upon the lips of every Jew that it passed over to a neighbouring nation; that the language of the inscription, which was infinitely more simple than two-thirds of the Old Testament, showed that the Moabites had attained to a high state of cultivation; that in military prowess they were superior to the Jews; and that from them the ancient Greeks and Romans, and we ourselves, had derived what had become our alphabet. In the course of the discussion which followed, Professor Rawlinson objected to some of the conclusions of Dr. Guisburg. He claimed for the Phœnicians the merit of discoveries attributed to the Moabites.

THE EARTH, ITS CRUST AND INTERIOR.

IT has long been believed that the Earth is composed of a molten mass enveloped in a solid crust, but the thickness of the crust has remained a subject of vague conjecture. Professor Sir William Thomson, however, now shows that no thickness less than 2,000 or 2,500 miles would enable the crust to resist the tide-generating force of the sun and moon. A thinner crust would be bulged up by a tide within the molten mass, like the tide of the ocean.

Experiments have been made during the operation of sinking the shaft of the Rose-Bridge Colliery, at Wigan, by which it was found that the temperature of the strata, which at a depth of 161 yards was 64½ deg., rose to 93½ deg. at 808 yards. The rise in temperature appeared to be 1 deg. Fahr. for every 54·57 ft., which nearly corresponds with that ascertained by Professor Phillips at Monkwearmouth, where the rise was 1 deg. for every 60 ft.

ENERGY OF THE SUN.

Mr. Norman Lockyer, in his concluding lecture on the Sun, delivered at the Royal Institution, after a few remarks on the amount of Energy the Sun contains (calculated as that of 7,000-horse-power to the square foot), alluded to the various theories respecting the origin of this energy and its maintenance. If the sun were a ball of fire it would soon be exhausted by combustion. The meteoric theory has been negatived by Adams; and Helmholtz's suggestion that the energy is due to contraction, and that 17,000,000 years' radiation would be supplied by the sun's contraction to the size of the earth, is also considered untenable. If the hypothesis of Laplace be accepted, that the sun was formed by the condensation of a great nebula, we may then suppose it to possess so vast a store of heat as to withstand a drain for countless ages, but yet that a time may come when each planet, having been one by one welded into the mass, the central luminary, in the silence of infinite space, will roll a cold, black, solitary globe, which possibly by collision with another orb may generate heat and light, another sun, and new worlds.

SOLAR DIAL.

A portion of a curious Solar Dial, found by M. Renan in Phœnicia, has been exhibited before the French Academy of Sciences. The dial is in stone, and the divisions are nearly obliterated: but M. Laussedat, professor at the Ecole Polytechnique, has been enabled to reconstruct it in wood. The face of the dial is conical, and the hour-lines are curved; the day is not divided into twenty-four hours, the dial only showing the time comprised between the rising and setting of the sun; the curvature of the lines was therefore necessary to indicate the variations.—*Athenæum.*

SOLAR RADIATION.

MM. Desains and Branly have communicated to the French Academy of Sciences some investigations on Solar Radiation. They have found that the calorific action of the sun increases in intensity with the altitude of the place of observation, but that the transmissibility of the rays through water decreases with the height. The transmissibility through water and alum was found to be greater in the morning than at noon.

WORK PERFORMED BY THE SUN'S RAYS.

The heat of the Sun is continually raising the temperature of the atmosphere, making it capable of absorbing water from the surfaces of rivers, lakes, and oceans surrounding the earth. This is called evaporation; and by it clouds are formed at various elevations above the earth's surface. The sudden cooling of the atmosphere by cold currents or by meteoric changes precipitates these clouds in the form of rain; dews descend at night from the gradual cooling of the atmosphere through the absence of the sun. The water which thus falls may be considered as the measure of the sun's evaporating power. In the torrid zone the annual rainfall and dew amounts to about 100 in., and in the extreme northern temperate zone the rainfall is about 20 in. annually. The mean of the two depths is 60 in. or 5 ft., which may be taken as the average fall of water upon the earth's surface. It is estimated that the average height from which rain falls is about 900 ft. Now, to ascertain the amount of work performed on one square mile of the earth's surface per minute, in horse-power, through the agency of the sun's evaporation. We have—square feet in one square mile, 27,878,400, depth of water 5 ft., height from which it falls 900 ft., weight of cubic foot of water 62½ lb. Minutes in one year 525,600, 1-horse-power 33,000 lb. Then $\frac{27,878,400 \times 5 \times 900 \times 6{\cdot}25}{525,600 \times 33,000} = 452$-horse-power. And $452 \times 8,000^2 \times 31,416 = 90,880,000,000$-horse-power, the measure of the sun's evaporating power on the surface of the earth in one minute of time, and this is continuous, day and night, month after month, and year after year. Now it is estimated that the total horse-power of all the steam-engines in the world is not far from 15 millions. Hence we see that the work due to the sun's evaporation is something more than 6,000 times the work of all the steam engines in the world, supposing them to work continuously day and night. How insignificant are the most stupendous works of man compared with those of his Creator!—*Mechanics' Magazine.*

CAUSES OF RAIN.

Mr. R. H. Scott has described, at the Royal Institution, the three principal causes of rain, and examples:—1, Ascending currents of air which produce the great tropical summer rains; 2, the contact of hot damp air with cold ground, which makes the west coast of continents so rainy; and, 3, the setting in of a cold wind after a warm one, and the reverse—as when a N.W. wind sets in after a S.W. wind, or when a S.E. wind follows a frost. The measurement of rain was next explained. An inch of rain over 4 square feet is equal to a gallon of water, or 10 lb.; over a square mile, to 60,000 tons. The wettest place in the world is Cherrapougee, where the fall is 600 in., taking place in 6 months. Our rainfall at the sea level varies from 60 in. at Cahirceveen in Kerry to about 20 in. on the east coast of England. In mountainous districts it sometimes amounts to more—as much as 140 in. at Scathwaite.

VIBRATION.

Professor Guthrie has communicated to the Royal Society a paper, "On Approach caused by Vibration," in which he states that, when a vibrating tuning-fork is held near a small piece of cardboard, the cardboard has a tendency to approach the fork. It was shown that no sensible air currents, having their source in the fork's surface, were established, and that therefore the approach could not be due to the expansion of such currents. The action of the card upon the fork and of the fork upon the card were found to be mutual, and also that one vibrating fork has a tendency to approach another. The probability seems to be that the vibrating motion of the fork was communicated by the air to the card, and that the approach was caused by the two vibrating in unison. Electrical attraction, and also the attraction of gravitation, are in all probability due to such vibrations, as was pointed out two centuries ago by Robert Hooke, among whose posthumous works a disquisition will be found upon this subject. Hooke showed that when a glass containing water was made to emit a musical note, the water rose upon certain portions of its sides from the vibration. By resuming the subject where Hooke left it, Professor Guthrie would probably be able to give us some insight into the nature of gravity and other attractive forces.—*Illustrated London News.*

LIGHT OF THE FIREFLY.

The spectrum of the light of the firefly has been examined, and it is found to be perfectly continuous, without traces of lines either bright or dark. It extends from about the line C in the scarlet to F in the blue, and is composed of rays which act powerfully on the eye but produce little thermal or actinic effects. In other words, the fly in producing its light wastes but little of its power.—*Ibid.*

ANGSTROM'S OPTIC RESEARCHES.

The President of the Royal Society, in his Annual Address, remarks:—The science of Optics is that in which Professor Angström has most distinguished himself; and it is said of him that his *Optic Researches*, published in 1853, contain the fundamental principles of nearly all that has been done since; and that he is "entitled to rank among the very highest of those who have within a few years developed the powers of spectroscopy to their present marvellous extent." The details of the skilful Swede's researches have been made known through the publications of the Royal Academy of Sciences, Stockholm, and the Royal Society of Sciences, Upsala. The chief points, whether of method or result, are ably set forth in the address; but we can find room only for a few passages from the list: they are such as will not fail to engage the attention of all who search the worlds of the sky with the spectroscope. Thus, in his investigations of the solar spectrum, Angström "found in the sun *thirteen metals, of which titanium has 200 lines. The total amount of metallic lines is nearly 800, including most of the strong lines, so that probably the sun has few elements which are not found on our earth.* There are some strong lines between E and G, whose origin as yet is unknown; one coincides with a line of bromine, whose presence is not probable. There are three strong magnesian lines not present in the sun; and oxygen, nitrogen, and carbon, so common here, are not detected there. He thinks the sun is not hot enough to make the first two luminous; carbon in the circuit of his battery shows no lines of its own, but those of its compounds. He doubts Plücker's notions of the same substance having different spectra, and thinks that the change is merely due to the increased temperature, which makes faint lines intense, and is disposed to think that the pillar-like appearance observed in some star spectra indicates a lower temperature than the black sharp lines which occur in others. The aurora and zodiacal light have in common a line ($\lambda = 5567$) whose origin is yet unknown. It must be admitted that this list is the exponent of intellectual power of first-rate excellence, and of additions to our knowledge which are not only intrinsically valuable, but are also eminently suggestive of ulterior progress. Nor can Angström's claim to priority of entrance into this wondrous region be disputed by any unprejudiced judge. Though Stokes and Thomson nearly at the same time drew the same conclusion as to absorption, and even satisfied themselves of the identity of D with the sodium lines—though Stewart, and still more successfully Kirchhoff, again brought it before the public three years after,—yet this is what happens to every inventor or discoverer. Others follow in his track, some perhaps more successfully than himself, but his right remains untouched."

NEW SPECTROSCOPE.

A Spectroscope of a very valuable description has been invented and constructed by Mr. Browning, and has been exhibited at the soirées of the Royal Society. An ordinary spectroscope, with a train of prisms, is a difficult instrument to use, because to see each part of the spectrum in perfection the prisms should be adjusted to give the minimum angle of deviation of the particular rays under examination. Thus fresh adjustments of the whole of the optical parts of the spectroscope are necessary to see to perfection each of the different lines of the spectrum. With Mr. Browning's new instrument whatever part of the spectrum may be in the centre of the field of view, the prisms and telescopes are always in the best position for viewing that part of the spectrum. To effect this the prisms and telescopes are mounted upon a hinged framework of bars of brass in such a way that when any line of the spectrum is brought into the centre of the field of view the prisms always stand so that the rays from that part of the spectrum shall be bent by the prisms as little as possible from their original direction before entering the instrument. When this is done the prisms are in the position known to opticians as "the angle of minimum deviation" for that particular line of the spectrum. A spectroscope which thus arranges the prisms automatically is necessarily rather an expensive instrument; the ordinary spectroscope, on the other hand, is very troublesome to adjust. The best instrument for ordinary observers who do not intend to plunge very deeply into the science of spectrum analysis is the "direct-vision spectroscope," in which compound prisms of peculiar construction are enclosed in a straight brass tube, and all the trouble of adjustment is rendered unnecessary. This instrument, however, is not so good for deep scientific research as the ordinary spectroscope. —*Mechanics' Magazine.*

SPECTRAL ANALYSIS.

Mr. Browning has read to the British Association a paper "On an Induction Coil specially arranged for use in Spectrum Analysis." When an induction coil is used for the purpose of burning metals, it is necessary to interpose one or more Leyden jars in the circuit. Such an arrangement, though efficient, is inconvenient. The glass jars are liable to fracture; are bulky, and require to be dry to perform well, and the wires connecting them with the coil are in the way, and liable to derangement. To obviate these difficulties the author constructed an apparatus, which consisted essentially of a flat mahogany box filled with plates of ebonite, which are coated on each side with tinfoil to within an inch of the edges. The contrivance generally used for holding the metals or containing the gas under examination is packed inside the lid of the box. When in use, this fits into a hollow screen on the top of the box. To set this apparatus in action it is only necessary to carry a fine wire from each of the terminals of the induction coil, and insert it in the connexions provided at each end of the box, as these are connected with the tin-foil with which the ebonite plates are coated. Mr. Spottiswoode suggested, that there should be a contrivance added, by which a greater or lesser number of the coated plates may be brought into action at will. This arrangement is very useful, as it enables the temperature of the spark to be regulated. The simplest and best method of employing the coated ebonite plates, however, is to place them in the base of the induction coil, underneath the ordinary condenser, and connect them with the terminals. When thus arranged, the dense thick spark may be obtained from any substance placed between the terminals of the coil, or in any apparatus which may be attached to them, and a great economy of time is effected.

NEW SURGICAL INSTRUMENTS.

MR. HAWKESLEY has exhibited to the Royal Society a Self-Illuminating Ophthalmoscope, constructed on a plan suggested by Dr. L. S. Beale, which can be used in full daylight. This is important, as it obviates the necessity for examining a patient in a dark room, and allows of his taking any convenient posture. Numbers of the visitors during the evening looked into a human eye, and saw the retina, and could compare it with those of a cat and a rabbit which were caged up on the table to undergo examination. At the same table, Dr. J. B. Sanderson exhibited a Sphygmograph, and a Stethograph—the one to show the beatings of the pulse, the other those of the heart. The principle of the instrument is pneumatic: tubes convey the impulses from the chest or the wrist to a drum, on which a delicate indicator makes every movement visible. The value of these instruments in diagnosis will be obvious to all medical practitioners. Dr. Sanderson had provided a subject whose heart, beating somewhat irregularly, enabled him to demonstrate satisfactorily the capabilities of his improvement.

SCIENCE AND THE WAR.

MARSHAL VAILLANT has drawn the attention of the French Academy of Sciences to a proposal of Professor Burggraeve for the adoption of Lead Foil in place of Lint. The lead is made to adhere to the flesh by some glutinous substance, and it is said that it has been found highly effective in many cases of workmen injured in factories. Lead is both cool and soft to the skin, and the sulphite of lead which is formed prevents putrefaction. Another great recommendation is, that the wound may be cooled, without removing the lead, by merely wetting the bandage with water; and thus the entrance of infected air, and consequently of morbid germs, is entirely prevented. In connexion with this subject, it may be mentioned that the war has brought into use a new kind of bandage or compress, combined with lint. French lint is not scraped, like ours, but merely old linen unravelled; that is to say, it consists of masses of thread, and is certainly not very soft; the new bandages are woven with a mass of long threads, like long-piled plush, on a portion of their surface; so that the bandage and lint are combined, and ready for instant application. It is proposed to give every soldier in the French army one of these bands, with the ends dipped in a solution of perchloride of iron, thus forming a compress against hæmorrhage as well as a lint bandage.—*Athenæum.*

SLEEP.

M. Sommer propounds a new theory of Sleep. His idea is that sleep is simply a result of the deoxygenation of the system, and he believes that sleepiness comes on as soon as the oxygen stored in the blood is exhausted.

CATALOGUE OF SCIENTIFIC PAPERS.

The fourth volume of the *Catalogue of Scientific Papers*, compiled and published by the Royal Society, has been brought out, whereby another large instalment of the literature of science becomes available to scientific men. The thousand pages comprised in this volume carry on the list of author's names from L'He to Poz, and between these will be found many well known in the history of science. Under Liebig appear the titles of 284 papers, and 33 others in which the famous chemist is joint author. In Botany, the late Dr. Lindley figures for 58 papers; and H. F. Link for 101, while the mathematician Liouville numbers 309. The Rev. Dr. Lloyd has 60 papers; the late Sir John Lubbock 73, and Sir Charles Lyell 74. The entomological papers by Hippolyte Lucas amount to 326. Gustav Magnus, a profound investigator of physical science, now deceased, has 66 papers; and Matteucci, who did so much for electro-physiology, has 247. Olbers shows 122 papers; Oersted 117; and 311 papers form a long zoological roll under Professor Owen's name. From these selections our readers may judge of the quality of this important book, and they will share our hope that no time may be lost in bringing out the subsequent volumes.—*Athenæum.*

GERM THEORY OF DISEASE.

Dr. Tyndall, in a letter to the *Times*, dated April 19th, 1870, gives, in a connected form, the evidence on which he relies, in favour of the above theory. Schrœder and Pasteur have demonstrated that air filtered through cotton wool is deprived wholly or in part of its power to produce animalcular life. Why? Experiment with a beam of light answers the question; for, while it proves our ordinary air to be charged with floating matter, the beam pronounces air which has been carefully filtered through cotton wool to be visibly pure. There are no germs afloat in it; hence its impotence as a generator of life. Again, Pasteur prepared twenty-one flasks, each containing a decoction of yeast, which he boiled, in order to destroy whatever germs it might contain. While the space above the liquid was filled with pure steam he sealed the necks of his flasks with a blow pipe. He opened ten of them in the damp still caves of the Paris Observatory, and eleven of them in the courtyard of the same establishment. Of the former only one showed signs of life subsequently. In nine out of the ten flasks no organisms of any kind were developed. In all the others organisms speedily appeared.

Pasteur ascribed this unexpected result to the subsidence of the germs in the motionless air of the caves. Is his surmise correct?

The beam of light enables us to answer this question also. I have had a chamber constructed, the lower half of which is of wood, and the upper half of glass. On the 6th of February this chamber was closed, and every crevice that could admit dust, or cause a disturbance of the air, was carefully stopped. The electric beam, when sent through the glass, showed the air at the outset to be loaded with floating matter. The chamber was examined almost daily, and a gradual diminution of the floating matter was observed. At the end of a week the chamber was optically empty. The floating matters, germs included, had wholly subsided, and the air held nothing in suspension. Here again the ocular demonstration furnished by the luminous beam goes hand in hand with the experimental result of Pasteur.

Next comes Professor Lister's observation regarding the filtering power of the lungs. Turning once more to the luminous beam, we find that it declares air so filtered to be free from floating germs. Hence its inability to produce putrefaction, and the accompanying manifestation of animalcular life. Finally, as if to clinch the purely scientific experiments by a practical result, we find Professor Lister actually employing cotton wool to ward off the atmospheric germs; and, by its agency, keeping a large class of wounds sweet and pure. It is this intimate welding together of two independent series of observations that is my reliance.

TIDAL EXPERIMENTS.

In the Report of the British Association Tidal Committee, with regard to certain Tidal Actions, in the Pacific, India, and China seas, upon the theory propounded by Sir William Thomson, it is contended, that upon a fortnight's observation as good a tide table of the Pacific, India, and China seas can be obtained as we now possess of the British and Irish sea-coasts. Mr. O. Byrne, however, denounces the theory propounded by Sir W. Thomson, as "not based upon any dynamical law, and has neither logical deduction nor mathematical accurateness." Mr. Parker explains the course which he has taken to discover the action of the diurnal tides at the mouth of the Indus. He says that the tide-wave can be traced from the Cape of Good Hope to the Arctic regions; and then comes the question, whether the wave disappears altogether on reaching the pole. He then propounds the theory that there is a compound diurnal tide due to the moon's transit a few hours before, and also that of four days' previously; in other words, it took four days for the tide to run round the globe, and then it came to sight again.

Electrical Science.

NOVEL TELEGRAPHY—ELECTRIFICATION OF AN ISLAND.

A CURIOUS discovery has been made by Mr. Gott, the superintendent of the French company's telegraph station at the little island of St. Pierre Miquelon. There are two telegraph stations on the island. One, worked in connection with the Anglo-American company's lines by an American company, receives messages from Newfoundland and sends them on to Sydney, using for the latter purposes a powerful battery and the ordinary Morse signals.

The second station is worked by the French Transatlantic Company, and is furnished with Sir William Thomson's delicate receiving instruments. These very sensitive instruments were found to be seriously affected by earth-currents, *i.e.*, currents depending on some rapid changes in the electrical condition of the island; these numerous changes caused currents to flow in and out of the French company's cables, interfering very much with the currents indicating true signals. This phenomenon is not an uncommon one, and the inconvenience was removed by laying an insulated wire about three miles long back from the station to the sea, in which a large metal plate was immersed; this plate is used in practice as the earth of the St. Pierre station, the changes in the electrical condition or potential of the sea being small and slow, in comparison with those of the dry rocky soil of St. Pierre. After this had been done, it was found that part of the so-called earth-currents had been due to the signals sent by the American company into their own lines, for when the delicate receiving instrument was placed between the earth at the French station and the earth at the sea, so as to be in circuit with the three miles of insulated wire, the messages sent by the rival company were clearly indicated, so clearly, indeed, that they have been automatically recorded by Sir William Thomson's syphon recorder.

Now, the American lines come nowhere into contact, or even into the neighbourhood of the French line. The two stations are several hundred yards apart, and yet messages sent at one station are distinctly read at the other station; the only connection between the two being through the earth; and it is quite clear that they would be so received and read at fifty stations in the neighbourhood all at once. The explanation is—the potential of the ground in the neighbourhood of the stations is alternately raised and lowered by the powerful battery used to send the American signals. The potential of the sea at the other end of the short insulated line remains almost if not wholly unaffected by these, and thus the island acts like a sort of great Leyden jar, continually charged by the American battery, and discharged in part through the short insulated

French line. Each time the American operator depresses his sending key, he not only sends a current through his lines, but electrifies the whole island, and this electrification is detected and recorded by the rival company's instruments.—*Mechanics' Magazine.*

THE ELECTRIC LIGHT.

PROFESSOR TYNDALL, in the closing lecture of his series on Light, delivered at the Royal Institution, states that the intense brilliancy of the Electric Light is due to the incandescence of the carbon points, which, by the fierce heat caused by the electrical current, are ignited to whiteness. The ends of the carbon points are, when the lamp is in action, about a quarter or half an inch asunder, and the space between them contains carbon vapour, which emits very little light. The light comes almost entirely from the solid points. When a spectrum of the light of the points is thrown upon the screen it is continuous—all the colours of the rainbow blending one into the other in a long unbroken line. But when the light from the carbon vapour is passed through prisms in the same way it does not give a continuous spectrum, but throws vertical bands of coloured light upon the screen, with dark intervals between the bands. Hence light, when analysed by prisms, gives some clue to the nature of its source. Light from ignited solids gives a continuous spectrum, whereas light from ignited vapours gives spectra broken into bands. The lecturer then placed a little lump of silver in a slight hollow in the top of the lower carbon point in one of the electric lamps, and brought the upper carbon point down upon it till the current passed and caused the silver to boil. A magnified image of the lump of boiling silver was thrown upon the screen, and above the metal was seen the vapour or steam of silver, emitting a very beautiful green light. White-hot silver gives a continuous spectrum like a rainbow; but the light from vapour of silver gives a spectrum of two green bands, which Professor Tyndall projected upon the screen so as to be seen by everybody present. Next he boiled a piece of the new metal thallium in the same way, and its vapour emitted a green light. But was this green light the same as the green light emitted by vapour of silver? To get the answer to this question the light from the thallium vapour was passed through prisms, and it gave a spectrum of one green band, which did not correspond in position with either of the green bands of vapour of silver. In the next experiments vapour of zinc was shown to emit a spectrum of red and blue bands. If several metals are together raised to the state of vapour, every metal throws its own spectral bands. A piece of brass, an alloy of copper and zinc, was vaporised, and both metals threw their bands upon the screen at the same time. Vapour of sodium threw a yellow band upon the screen.

The next experiment was one of very great philosophical importance. A continuous spectrum from the carbon points was projected as usual, but in front of the electric lamp the light was made to pass through some ignited sodium vapour: under these conditions the vapour caused a dark band to appear in the yellow part of the spectrum, but left all the rest of it untouched. Other vapours, placed similarly in the path of the rays, have the power of showing their own bands, but dark instead of light. Now, when the light of the sun is examined with a spectroscope, a spectrum is seen, cut here and there with dark lines. This proves that between the source of the light of the sun and our eyes there is an atmosphere of fiery vapours, absorbing some of the light emitted by the incandescent particles on the other side of the vapours. By mapping the lines and measuring their positions in the spectrum, the vapours which produce them are known, and in this way philosophers of late years have found out so much about the nature of the sun. In the spectroscope proper the eye takes the place of the screen used in lecture experiments. A Bunsen's flame, which gives plenty of heat and little light, has some of the substance to be examined placed in it on a loop of platinum wire; the substance is then volatilised by the heat, and gives a colour to the flame. Some of the coloured light then passes through the slit of the spectroscope and a series of lenses and prisms, whereby the spectrum of the substance volatilised is thrown upon the retina of the eye. Dr. Tyndall closed the lecture with a few experiments with polarised light.

APPLICATION OF THE ELECTRIC LIGHT.

It is unquestionable that, when properly managed, the Electric Light can be applied to a host of useful and scientific purposes. In consequence of its brilliantly vivid and scintillating appearance it is especially well adapted for the purposes of signalling, either on land or water. Through its agency the observations for joining England and Ireland in the great trigonometrical survey of Great Britain were obtained with an ease and accuracy that would at one time have been regarded as impossible. By means of theodolites of very large size, especially constructed for the purpose, carrying telescopes of commensurate optical range, the signals on the coast of Wales were observed at night-time from the opposite shore with a fidelity that left nothing to be desired. By placing the electric light at a sufficient height a number of operations that are frequently of a very urgent and important character could be carried on in the night as well as in the daytime. For example, it is extremely desirable sometimes to unload or load a ship at night, which is only performed under ordinary circumstances with a good deal of confusion and uncertainty, owing to the very indifferent artificial light to be obtained. As a means of lighting vessels, that do continually run foul of one another, although there is the whole ocean to choose between them, the electric light would prove invaluable. If every vessel carried an electric lantern at her foremast a collision would be next to impossible, unless everyone on board were asleep. This light, as it has been well remarked, affords the means of having daylight at pleasure. All the piers along the river from Sandy Hook to New York are provided with it, and the advantage to the steamers, which also carry the light themselves, navigating a stream full of vessels and ships of every possible size, is incalculable.—*Mechanics' Magazine.*

ELECTRICAL PHENOMENA.

At the Royal Institution, Professor Tyndall, in his fourth lecture, has given additional illustrations of the powers of the Electric machine and Leyden battery, employing for the purpose an ebonite machine and a large battery constructed by Mr. Cromwell Varley, the telegraph electrician, and kindly lent by him. Very long sparks were produced, and silver wire was deflagrated. The Professor then commented on the differences between voltaic and frictional electricity, and referred to the celebrated experiments of Davy, who charged a Leyden battery with voltaic electricity, and obtained from it a spark four inches long, and fused platinum, quartz, and other hard substances. The great and costly battery employed by Davy was supplied him by the voluntary subscriptions of certain members of the Royal Institution, in 1808. Professor Tyndall next described and illustrated the experiments of Faraday, made with submarine electric telegraph cables in 1854, whereby, in common with Werner Siemens, he was led to compare a cable to an enormous Leyden jar, the wire forming the interior and the water the exterior coating, the gutta-percha being the insulator between them. By thus observing the effects of induction, Faraday and Werner Siemens were enabled to explain the varying velocities assigned to the electric current by different experimenters, and to prove that electricity requires an amount of time to pass through any conductor directly proportional to the length of the conductor. In submarine cables the charging the cable by the battery is another cause of retardation. To illustrate these points, Professor Tyndall employed one of the artificial cables invented by Mr. Cromwell Varley, being assisted by that gentleman. In this cable a resistance equal to that of a real cable 14,000 miles long is obtained by introducing into the path of the current feebly-conducting liquids instead of metallic wires, the inductive action being obtained by means of condensing-sheets separated from each other by thin sheets of paper and parafin; the vastness of the area and the proximity of the inducing surfaces combining to exalt the effects. When these condensers, charged by a battery, were discharged, precisely similar phenomena to those of a Leyden jar were obtained; and when a series of fifty condensers was arranged in Franklin's "cascade" (the outer coating of each being joined to the inner coating of the next) and charged with a battery of a thousand cells, very powerful sparks were produced, and wires were deflagrated. When the wire was bent and introduced into a tumbler of water, the very strong glass was shattered by the discharge. Mr. Varley supposed his 14,000-mile artificial cable to be divided into sections representing nine stations between London and Australia, and by placing galvanometers at these stations he obtained successive deflections when battery contact was established. He also connected with the needle of the tin galvanometers a small reflecting mirror, from which a brilliant spot of light was cast upon a screen. When the cable was not in action the ten spots formed a row along a vertical line; but when the battery contact was made, the successive deflections of the galvanometers were declared by the successive motions of the spots.

Professor Tyndall, in his brilliant course, delivered at the Royal Institution, among his numerous illustrations exhibited the powers of the great electro-magnet employed by Faraday; and a model engine, by Froment, showing how the force of electro-magnetism may be applied to pumping water and pile-driving. He also showed how a musical tone may be obtained from the rapidly successive clinks, produced whenever the electric circuit is alternately made and broken; and then, by an ingenious arrangement of levers and mirrors, he demonstrated the truth of Joule's discovery, that a bar of iron is lengthened when magnetised, its volume being unchanged. The formation of the magnetic curves (termed by Faraday "lines of force"), by the movement of iron-filings strewed on a sheet of paper placed over two bar-magnets, was beautifully shown on the screen by means of the electric light; and reference was made to De la Rive's acute suggestion, that the elongation of a magnetized iron bar may be due to a similar movement in its minute particles.

The Professor described the celebrated induction coil constructed by Ruhmkorff, in which an automatic apparatus is employed to make and break contact with the battery. The induced currents evoked in these coils, it was said, may possess thousands of times the electric force of the primary current which excites them; and by the inductorium of Mr. Apps sparks eighteen inches long are produced. The latter part of the lecture was devoted to the exhibition of the brilliant effects of the electric discharge upon highly rarefied gases in Geissler's vacuum tubes. Every attenuated gas was shown to possess its own characteristic colour; and the rosy light of rarefied air was attributed to the same origin as that of the aurora borealis—the nitrogen of the air. Reference was specially made to the profound researches of Mr. J. P. Gassiot in relation to this subject. By means both of the electric machine and a battery of 3,500 cells, he produced the beautifully distinct strata in the luminous discharge. Professor Tyndall showed, in a most striking manner, that this luminous discharge is really an electric current, and is acted upon by a magnet, like a wire conveying a current. The discharge was deflected, extinguished, restored, or modified in brilliancy by the action of an electro-magnet. Observations on the importance of combining experiments with theory concluded this brilliant and instructive course.

ELECTRO-PHOTOMICROGRAPHY.

Lieut.-Colonel Woodward, assistant-surgeon in the United States Army, finding his endeavours to carry on Photomicrography by sunlight baffled by variable weather, has experimented with the magnesium light and the electric light, and with entire success, even with the highest powers. He makes use of a Duboscq's lamp, in connexion with a small Grove's battery of fifty elements, and finds that he can accomplish therewith all that can be done with sunlight in photomicrography, and with the advantage that the exaggeration of light and shade imparts to feeble microscopical images of highly magnified objects a clearness of definition beyond that hitherto produced by sunlight on similar objects. He finds, moreover, that the electric light is more manageable than sunlight as a source of microscopic illumination, and requires a shorter exposure of the plate, and that for the highest quality of work it is preferable to the magnesium light.

When photographs are to be taken by this method the electric lamp is set in operation, the table holding the microscope is shifted until the centre of the achromatic condenser coincides with the centre of the illuminating pencil from the lamp: the object is then placed on the stage and carefully adjusted. A cell of plate glass containing a saturated solution of the ammonia-sulphate of copper is fixed just below the achromatic condenser; and this, as Col. Woodward explains, not only prevents the passage of non-actinic rays, but excludes the great heat produced by the electric light, and moderates its effects on the eye. In fact, he describes the light as "very agreeable to the eye," and finds himself "able to work with it from four to five hours without fatigue." And there is the further advantage that all the colours of the objects examined disappear, and they show black on an azure field, whereby the observer can tell beforehand how they will appear in the photograph.

The *American Journal* gives the method of operation, with a list of the most remarkable objects thereby represented. These, as the editors state, surpass in perfection and beauty any specimens of photomicrography they had yet seen.

ELECTRO-MAGNETIC ANEMOMETER.

Mr. J. J. Hall has described to the British Association this new instrument of his invention, and the mode of using it in registering the velocity and pressure of the winch.

The anemometer consists of two parts, viz. velocity apparatus and registering apparatus. The first consists of a set of Robinson's hemispherical cups, which communicate their motion downwards into a brass box, where it is reduced in angular velocity and causes a contact disc or commutator (in which two platinum contact pins are fixed equidistant from one another) to revolve in 1-10th mile. An insulated metallic lever having a platinum working face, stands on either side of the disc, so that upon the completion of every 1-500th mile one or other of the contact pins comes in contact with the two levers, thus uniting them and completing the circuit. The levers are raised a few degrees and then fall back to their normal position ready to be taken up by the next pin, and so on.

The recording apparatus consists of a train of wheels and pinions working in a frame or between two brass plates, the arbers of which project through a dial plate, whereon the circles and figures are engraved and carry the hands. These wheels are driven by a weight attached to a line wound round a barrel, and a locking pin disc (the pinion of which works in the first wheel) is released at every contact of the cup apparatus by an electro-magnet, which unlocks the pin disc and allows the first hand to advance 1-500th mile on the graduated dial by a jump similar to the minute hand in remontoire clocks.

By turning "on" a "strike-silent" stop a hammer lever is brought into connection with the escapement, and strikes a bell at every contact. In this arrangement the observer has nothing to do, as regards visual attention, but to notice the seconds' hand of his watch or chronometer (a centre or split-seconds or chronograph would be preferred) while he counts the number of times that the bell is struck, each of which corresponds to 1-500th of a mile, and by formulæ arranged and exhibited by Mr. Hall (who has also arranged a comprehensive series of tables for use with this instrument) the hourly velocity may be readily deduced.

QUADRANT ELECTROMETER.

Sir William Thomson's Electrometer, with an improvement by Mr. Becker, has been exhibited by Elliott Brothers at the Royal Society. In two pieces were specimens of Faure's new carbon battery; and the India-rubber, Gutta-percha, and Telegraph Works Company showed a Leclanche battery which, with cells of peroxide of manganese and zinc and a saline solution, effects a great economy in the work ordinarily required of an electric battery. But as regards battery work, the chemist of the Mint, Mr. W. C. Roberts, availing himself of Jacobi's process, has achieved something surprising with his specimens of electro-deposited iron. The source of the deposit is a solution of sulphate of iron and sulphate of magnesia; the rate of deposit is about the same as with copper, and the iron thus obtained is so hard that it will scratch glass, and has been found eminently useful for cliches and plates for printing purposes. Among Mr. Roberts' specimens were bank note plates, medallions, mouldings, and raised work of various kinds; and one plate had been converted into steel by a process which was not revealed. It is easy to foresee that so successful a method of depositing iron of exceeding hardness may be largely employed in giving a surface to rough iron castings.

IMPROVED LANTERN.

An Improved Lantern for lecture demonstrations with the Electric Light has been completed by Mr. W. Ladd. In illustrating spectrum analysis, much inconvenience has been experienced in the use of two lanterns, or, where limited to one, in the time and trouble in shifting optical arrangements. The author had therefore devised a lantern, by which all the required demonstrations can be performed. The body of the lantern is of brass tube, 9 in. in diameter, in the centre of which is fixed the electric light. At two points in the tube, situated about 100° apart, are openings, to one of which is attached a flange, into which the various optical arrangements slide; the other opening has a sliding piece, carrying a second and similar flange, so that the various pieces of apparatus are mutually interchangeable. By pointing one of these openings direct on to a screw, the other will be in a proper position for a ray of light passing through two bisulphides of carbon prisms, to give the spectrum on the same screen. The lamp can, without being opened, be adjusted to keep the light absolutely central—a desideratum every one will admit who has had to use a microscope or polariscope with the electric light. Within the lantern is a small gas jet, to enable the operator readily to change the carbon-points. A revolving carbon-holder is also provided, carrying five separate carbons, and, by simply rotating, each is successively brought into action: thus, by once charging, several experiments can be performed with rapidity.

NEW CONSTANT BATTERY.

This new form of battery has been designed by Mr. Octavius Varley, for the purpose of removing the defects of the otherwise constant battery of the late Professor Daniell. In this form of battery, the porous chamber, which has been the source of all the trouble, is removed. The battery comprises a water-tight compartment for the copper-salt, a connecting column of fluid, and a compartment for the zinc-salt. These are so arranged, that whilst the electro-chemical continuity is completed at the top of the copper-chamber, no intermixture of the salts can take place; convection currents, which are the great source of intermixture, are divided into three separate systems, which cannot possibly interfere one with another. Whilst economy of the copper-salt is effected, greater uniformity and higher potential is maintained. The zinc-plate is found to work out to the very last, being kept free from the coating of copper to which all batteries hitherto constructed are liable.

EFFECT OF ELECTRICITY ON WINE.

In a communication made to the French Academy, M. Scoutetten states, it had been found by experiment that the quality of indifferent wine was greatly improved by sending a voltaic current through it for about a month. No doubt the efficacy of the process would materially depend upon the nature of the imperfection in the wine.

MAXIMUM MAGNETIC POWER.

A paper has been read to the British Association, 'On the Maximum Amount of Magnetic Power which can be developed by a given Galvanic Battery,' by Mr. H. Highton. The author's object was to show that, by means of any galvanic battery whatever, electro-magnets might be made capable of sustaining any amount of weight without limit. It was shown, both by mathematical formulæ and experiment, that this was the case, as also that a constant weight could be sustained, while the expenditure of zinc in the battery could be at the same time continually diminished without limit. In the discussion which followed it was pointed out, that this was a mere power of sustaining weights, and not an energy such as could be applied to working an electro-magnetic engine; for that, if the magnets were used to work an engine, the currents produced by the reaction would cause an increased consumption of zinc.

ELECTRIC BUOY.

An Electric Marine Buoy, the invention of M. E. Duchemin, has been exhibited at Cherbourg. The electricity was produced by the constantly-renewed action of the sea-water on zinc, but the inventor has since carried on a series of experiments in order to ascertain if an increase of intensity could not be obtained as in ordinary batteries by means of certain chemical substances held in suspension around the zinc or charcoal element. The new battery resulting from the experiments consists of a porous vase fixed on a wooden buoy or floater. The vase is surrounded by a thick zinc cylinder, pierced with holes, the wire of which represents the negative pole. Within the porous vase is placed a slab of gas-retort charcoal, to which is affixed the conductor of the positive pole; the charcoal is surrounded by pieces of coke and perchlorate of iron. The vase is carefully closed, and the battery when plunged in the sea immediately gives forth large quantities of electricity.

ELECTRICITY AND PRINTING.

Sir Charles Wheatstone has just added to his many electrical inventions the completion of a Printing Instrument. This resembles a piano, having a key-board of 25 notes, each answering to a letter in the alphabet, several of which can be used for stops and numbers. The most frequently occurring letters are situated towards the centre, so that an operator need rarely move his hands from one position. Great speed is thus obtained, and the advantages of this invention are manifestly great, as, if necessary, a printed copy of the forwarded message can be had by the sender of a message.

ELECTRO-TELEGRAPHY.

It has been found that Telegraphic Messages at isolated stations are liable to be stolen, not only by the surreptitious attachment of a recording apparatus to the wires, as was done in India during the cotton fever, but by the introduction of a short insulated wire in the neighbourhood of the station, which would intercept the artificial earth currents produced by the working of the line, and thus reveal the purport of the messages which were being conveyed. The remedy for this inconvenience is the use of an earth plate placed at some distance from the station, and buried, if possible, in the sea; and by connecting the station with this plate, the earth currents would be discharged in the line of least resistance, and could not afterwards be made to surrender the secrets they convey.

PORT ELIZABETH TIME SIGNAL.

Mr. S. A. Varley, when requested to construct the trigger for this signal, as he considered the use of relays or secondary apparatus to be objectionable in time circuits, determined, if possible, to construct the apparatus sensitive enough to be discharged by the batteries of Cape Town. The trigger was discharged by one through current from batteries 500 miles distant; but the action of the trigger was much more rapid than previous ones; the time absorbed by the apparatus in discharging being only one-twentieth of a second; and the actual time elapsing between the current leaving Cape Town and the receipt of a return current announcing the falling of the ball, were only one-fifteenth of a second.—*Proc. British Association.*

LIGHTNING AND TELEGRAPH, AND NEW COILS.

Mr. S. A. Varley, in a paper read to the British Association, states: Lightning protectors were very generally adopted in the early days of telegraphy, but subsequently were practically abandoned, as they were not found to save the coils, or only exceptionally. When storms occur in the neighbourhood of telegraph circuits, powerful electric currents are often induced in the telegraph wires, which, in some cases, may be strong enough to fuse the coils, but which are more often demagnetized, or reversed by the magnetism of the magnetic needles inside the coils. The interruption which lightning causes on telegraph circuits is more important than the destruction it causes to the apparatus. Needle telegraphs are very generally employed by railways, on account of their simplicity; and communication on railways is consequently liable to serious interruption when storms occur. In 1866 the writer introduced instruments which he believed to fulfil most of the conditions of an efficient instrument, and gave the result of direct experiments with electricity of tensions varying from 12 to 700 cells of Daniell's battery, which had furnished the data from which he had designed his lightning-bridge. The lightning-bridge consists of two metallic pointed conductors, approaching to within one-eighteenth of an inch, and surrounded with a mixture of conducting and non-conducting matters in a minute state of division. The action of the lightning-bridge placed in a circuit struck by lightning is thus: the lightning finding in its direct path a bridge of conducting particles, in very close proximity to one another, which are connected under the influence of a discharge, and the matter rendered highly incandescent, offers a very free passage to the secondary current developed by the demagnetization. There are upwards of 1,000 of these bridges doing daily duty in this country alone, and not a single case of a coil being fused when protected by them has occurred. The change in the administration of the telegraphs has been inaugurated by the adoption of induced magnets for needle telegraphs, and consequently a great impulse has been given to their introduction. This form of coil has been adopted by the Government.

THE ELECTRIC TELEGRAPH.

It records little to the honour of the country wherein the Electric Telegraph was originated, that, 56 years after that important event, its originator has been rewarded with a knighthood. The recipient in this case is Mr. Francis Ronalds, who, upon the suggestion of Cavallo, constructed a perfect Electric Telegraph employing frictional electricity, although Volta's discoveries had been known in England for sixteen years. "This telegraph was exhibited at Hammersmith in 1816, the very year in which Andrew Crosse, the electrician, said: 'I prophesy that, by means of the electric agency, we shall be enabled to communicate our thoughts instantaneously with the uttermost parts of the globe.' Ronalds' telegraph consisted of a single insulated wire, the indication being by pith balls in front of a dial: when the wire was charged, the balls were divergent, but collapsed when the wire was discharged: at the same time were employed two clocks with lettered discs for the signals. Ronalds' success was complete; nevertheless, the Government of the day refused to avail itself of his telegraph." (*Stories of Inventors and Discoverers*, 1860.) The remainder cannot better be told than in the words of the *Pall Mall Gazette*, a journal by no means accustomed to the mealy manner, but preferring truth. Ronalds, on offering his telegraph to the then Government, we are told, "received an answer which can never be too often cited as an illustration of official complacency: 'Telegraphs of any kind are now wholly unnecessary, and no other than the one now in use will be adopted.' Nothing daunted by this apathy, Mr. Ronalds matured his invention, and in 1823 published a 'Description of an Electric Telegraph, and of some other Electrical Apparatus.' Mr. Ronalds was too far ahead of his time, and too purely a man of science to secure a hearing for his discovery in those early days; and it was left to others to mature his idea, and to establish the system which his prophetic eye had foreseen would one day transform the world. It was not till 1837, fourteen years after Mr. Ronalds' pamphlet, that Messrs. Cook and Wheatstone took out their first patent. The science and practical skill of these and other eminent electricians have brought electric communication to its present advanced state; but the great fact remains, that Mr. Ronalds was the first to demonstrate practically the principle which they have developed. At last, thanks to Mr. Gladstone's sympathy with genius, the special merits of Mr. Ronalds as a pioneer in this great field of action have received a public recognition. Mr. Ronalds, although still an active devotee of science, is now in very advanced age. A little longer, and his honours might have come too late." And the year in which this honour was so tardily bestowed was the first year of "State Telegraph Management," of which we select the following from the *Echo*:— "When the Government took possession, on January 18, the Companies had in their employment 2,035 male clerks, 471 female clerks, and 1,471 messengers. Seven months later, on August 31, this number had nearly doubled, for the Post Office was employing 2,638 male clerks and 874 female clerks, 740 assistant male clerks, 661 assistant female clerks, and no less than 2,802 messengers. It is pleasant to note the large proportionate increase in the number of females employed; pleasanter still to learn that it is due to the experience that girls are found as a rule to make far more efficient and reliable indoor clerks than lads of the same age. On September 30 the number of female clerks employed was 901, as against 479 employed by the companies, and of these 752 were employed in London.

"The additional facilities afforded under the new management are to some extent indicated by the fact that 800 new stations have already been opened. The rental paid by the Government is actually 12,000*l.* a year less than that paid by the companies.

"Then, again, the telegraph lines throughout the country have undergone a thorough overhauling and repair, whilst they have been extended in every direction. In London a new and complete system has been created. This has involved the laying down of many miles of pipes, and nearly 800 miles of underground guttapercha-covered wires. Every money-order office has been connected with its sub-central district office, so that local needs are fully met, whilst the collection and delivery of provincial messages have been immensely facilitated.

"Pneumatic communication has been largely extended both in London and the larger provincial towns. Improvements have been made in existing instruments. The Wheatstone instrument, which transmits messages with greatly increased rapidity, and thus increases the working power of the system without any sensible addition to the working expenditure, has been put on as quickly as it can be obtained. Unluckily, however, the war has taken away most of the German artisans who make it; and ten Wheatstone instruments are, we understand, at present locked up in Paris. The total number of instruments of all kinds in use and to spare when the transfer took place, was only 1,869; on August 31, there were 4,153.

"But perhaps the most important and significant consequence of this first year of telegraph management has been the 'straightening of routes.' The amalgamation of the different lines has enabled the department to add greatly to the efficacy of the system, at the same time that it has saved something over 1,400 miles of wire by a careful re-arrangement of circuits."

PROGRESS OF OCEAN TELEGRAPHY.

FROM an exhaustive article in the *Times* we quote the following:—"When the *Great Eastern* returns from Aden she will immediately carry out a cable to extend from Falmouth, by way of Gibraltar, to Malta, where it will join the present Malta and Alexandria cable, and will complete the direct line from England to Bombay. From the southernmost point of Ceylon a cable will then be carried to Singapore, touching at Penang and Malacca. From Singapore one line will proceed north to Hongkong, Amoy, and Shanghai, and another south to Batavia and through Java to Port Darwin at the north of Australia. Thence a coast line will be taken round the eastern side of the Australian continent to Burketown, Cardwell, Rockhampton, Brisbane, and Sydney, uniting with the telegraph from Sydney to Melbourne and Adelaide, and with that from Melbourne to Launceston and Hobart Town. From Hobart Town a cable is projected to New Zealand; and, to complete the circle round the world, some American capitalists have been negotiating for another across the Pacific, from China to California, by way of Japan and Alaska. We may fairly assume that, in 1874, our readers will be supplied with news, not twelve hours old, from every part of the civilised globe.

"Of the enormous system which we have thus sketched in outline it may be said that the whole will be constructed by British skill and energy, and the larger part by British capital. The cables will all be manufactured by the Telegraph Construction and Maintenance Company, and will be laid by the *Great Eastern* and her consorts. Excepting in the island of Java and at the Isthmus of Suez, the wires will be either submerged or upon British territory; and on the isthmus it is proposed that they shall be deeply buried. A submerged cable is practically quite secure. No single speculator can find any means of injuring it for his private gain. As long as England holds the empire of the sea the cables will be safe from enemies in time of war. To grapple and raise them would require not only a knowledge of their exact position, and a ship specially fitted with proper apparatus and trained hands, but, also, more time than could be given to the task. The electric lines will lie beneath the great highways of traffic, and no grappling ship in search of them could herself escape notice, or, encumbered as she would be by her machinery, could avoid falling an easy prey to cruisers."

SECRET TELEGRAPHY.

THE importance of information and co-ordinated action between the outposts of a defensive military system and its head-quarters ought to direct the immediate attention of our Government to the subject of Secret Telegraphy. At present a spy, a traitor, or a shell might destroy the only means of communication which our ports and stations can hold with London and with one another; whereas any temporary position, and even Portsmouth, ought to be able to hold free intercourse with sources of succour and centres of command if invested on all sides by an enemy. This could be done by two or more cables sunk in a machine-made slit in the land and sea bottom, at such a depth that no ordinary amount of grappling or digging would disturb both or all. These could then be secretly led, under highways and bye-ways, by a roundabout course, to London, and they would undoubtedly prove of immense value in time of war, either at home or abroad. Again, when this empire will become a great maritime league of English states—with which our "United" brethren across the Atlantic may either be absorbed, or very closely allied—it will be of vital importance in case of danger if safe, secret submarine cables were ready to summon the men in nations and war-ships by thousands from every detached portion of the empire to the aid of any threatened point of its world-wide territory. In future the course and landing-place of submarine telegraph cables should, as far as possible, be known only to the central government. Those at present laid could be destroyed in a night, and, even if declared neutral in war, could not be protected twelve hours from the officious malignity of home or foreign enemies.—*Pall-Mall Gazette.*

GAS-LIGHTING BY ELECTRICITY.

AT the Industrial Exhibition at New York, an apparatus has been shown for Lighting and Extinguishing Gas by means of Electricity. The lighting by electricity we understand; the mode of extinguishing is probably the simple process of turning off the supply. Very many inventors have occupied themselves with a plan for igniting simultaneously all the public lights in a district; but the obstacles to be overcome are many, and the cost of the electric fluid would probably be greater than the wages of the lamplighters amount to. The apparatus has been applied with success to the Capitol at Washington, where more than 3,000 jets are lighted at the same moment, and also to the large stores of Mr. Stewart, in New York, which have over 2,500 lights. In this country the only application of electricity to the purpose is in the theatre of the Royal Institution, where the sunlight is re-ignited by the electric spark when the gas has been extinguished for the exhibition of experiments. There is no probability of seeing the plan adopted in our streets, for if sufficient electrical power could be obtained at a reasonable cost, separate mains would be required for the service of the public lights, unless the invention includes an arrangement for turning off the gas from each individual lamp.—*Mechanics' Magazine.*

THE "INSTRUMENT ROOM" OF THE ELECTRIC TELEGRAPH.

THIS room, the most sensitive spot in the whole world—the cerebrum which receives and transmits intelligence from all quarters of the globe—may be looked upon as one of the most curious sights in the metropolis. Hundreds of minds are simultaneously conversing, some with tongues of steel, some with the clear sound of the bell, some again by means of piano-like notes, which spell the words letter by letter—the metallic tinkle of the electric bell, hailing from distant and western cities—not a human voice is heard—although, stranger still, the manipulators are all women. Whilst the visitor is listening to the clatter of one half of the world talking to the other half, he is aware of a dull thud striking from time to time upon the ear. On inquiry, he finds this strange sound proceeds from the pneumatic tube, the new servant the electric telegraph has called to its aid; and within a glass case against the wall he sees trained, just like so many fruit-trees in an orchard house, long tubes of gutta-percha, ending in an oblong-shaped mouth, covered with thick plate-glass. As he is watching, a long, round pellet is projected into this reception case with the force of a spent shot—taken out by the clerk in attendance—and immediately opened. It contains a telegraphic message, sent here for transmission to some other wire. This pneumatic tube at present is only extended to offices half a mile round. Eventually all the great district post-offices will be connected with the central office by pneumatic tubes, thus vastly accelerating the speed of the telegrams. In addition to the offices within half a mile of Telegraph Street, which are thus served by this aërial Mercury, the head office at St. Martin's-le-Grand is provided with a tube. The great sub-marine cables, such as the Atlantic, the Indian, and all the marine lines wishing to use the central office as a means of forwarding messages, will have lines of tube to this room for that purpose. The telegraphic message comes in a round plug-box, covered with carpet or flannel, so as just to make it fit loosely the tube. The suction and propulsive power lies in the depths of the establishment, in the shape of a steam-engine.—*Edinburgh Review.*

Chemical Science.

DUST AND DISEASE.

In his researches on the decomposition of vapour by light, Professor Tyndall was for a time considerably embarrassed by the presence of floating atoms, such as we see when a ray of sunlight enters a dark apartment, and which are so much dust lit up by the solar radiance. It was the object of Professor Tyndall to obtain air which should be free from these atoms. But he found that their exclusion was a singularly difficult task. Whether he passed a current of air through concentrated sulphuric acid, or through a solution of caustic potash, the air which bubbled up carried with it into the experimental tube a certain quantity of suspended matter, which became visible when the tube was traversed by a beam of electric light. There could be no doubt of the result, seeing that the exhausted tube exhibited no particles of matter prior to the admission of these air currents. At length the Professor tried another plan, and subjected the air to the flame of a spirit lamp. This done, the floating matter no longer appeared, having been burnt up by the flame. The important conclusion was thus arrived at, that the floating particles which the flame destroyed were composed of organic matter. One marvellous incident in the investigation was the appearance of blackness which resulted from subjecting air to the action of heat. This blackness, though greater than that of the densest smoke, was found to be mere nothingness—a vacuity arising from the fact that there was nothing to see. Light itself is invisible. A beam of electric light appears to be cut asunder if its path be intercepted by a portion of air containing no particles of floating matter. One valuable result accrues from these researches. A little cotton-wool will so filter the air on its way to the lungs as to arrest the floating particles. Air thus inhaled and afterwards breathed out again, produces the same kind of blackness as that occasioned by the purifying action of the spirit-lamp. Hence the value of a cotton-wool respirator for invalids and those who attend on the sick. By such means Professor Tyndall asserts, "so far as the germs are concerned the air of the highest Alps may be brought into the chamber of the invalid." These researches have been the subject of a most attractive lecture by Professor Tyndall, at the Royal Institution; but Professor Foster had stated to the British Association, that Dr. Angus Smith had for many years investigated the question. Dr. Angus Smith said, it seemed to him that actions of immense variety would take place from varieties in the dust; they might imagine, in fact, an infinite number of actions. If there is such a thing as a cholera germ, it would produce an analogous cholera fermentation. Why should it not be the case that, when these germs passed over the world, they should introduce cholera germs into organic bodies through the medium of inorganic substances? Filth might take the disease, afterwards transferring it to human bodies. It might therefore be supposed that every quality of germ would give its own form of fermentation. One of the most important inquiries in reference to this subject was, to endeavour to discover what quality of fermentation takes place when certain qualities of germ are employed. Professor Williamson said that the question had been energetically investigated with fruitful results on the Continent, and it was deplorable we should be so little cognizant of what had been done. Chemists were not of themselves competent to deal fully with this matter, inasmuch as it included a knowledge of organic processes going on in life.

Professor Tyndall's lecture upon dust has attracted such general attention, that it need not be further referred to here than to state, that the only point in connection with it which appears to be new is that cotton wool is an effectual strainer, which will separate organic germs which may otherwise produce disease. The nature of the impurities existing in the atmosphere had before been investigated. But Professor Tyndall has directed attention more forcibly to the probable influence of these impurities in the propagation of disease.

AN ASBESTOS AIR FILTER.

A VERY good suggestion for an air filter, equally applicable for a ventilator or a respirator, is made by M. Woestyn, who proposes to place in a ventilating shaft a bag of asbestos. This, like cotton, will arrest any solid particles floating in the air, and when much soiled the asbestos can be removed and made white hot, by which all organic matters will be destroyed, and it may then be put back in the shaft again. For respirators asbestos would be far preferable to the cotton wool proposed by Dr. Tyndall. It would not hold moisture like the wool, and would at the same time be most efficacious as a filter; and made so that the asbestos could be easily removed to be burnt and put back again, and they might come into use and be highly recommended. There would be obvious difficulties in the way of effectually filtering the air admitted to a large building, but we agree with M. Dumas in considering that the suggestion of M. Woestyn is worthy of serious attention.—*Mechanics' Magazine.*

DIFFERENCE OF DUST.

THE Dust obtained from the places of amusement in New York has been analysed by the scientific officers of the Metropolitan Board of Health. Over one hundred specimens of the particles floating in the air and falling as dust, were collected on plates of glass and were examined under the microscope. The proportions of the different ingredients varied, but the same substances were found in all the specimens. The composition of the matter subjected to the microscope was as follows: "The dust of the streets in its finer or coarser particles, according to the height at which it had been collected, with a large proportion of organic elements; particles of sand, of quartz and feldspar; of carbon from coal dust and lampblack; fibres of wool and cotton of various tints; epidermic scales; granules of starch, of wheat, mainly the tissues of plants; the epidermic tissue, recognized by the stomata or breathing pores; vegetable ducts and fibres, with spiral markings; vegetable hairs or down, either single or in tufts of four or eight, and of great variety, and three distinct kinds of pollens. Fungi were abundant from mere micrococcus granules to filaments of mould. When water was added to a portion of dust from whatever source, and exposed in a test tube to sunlight or heat for a few hours, vibriones and bacteria made their appearance, and the fungous elements sprouted and multiplied, showing that they maintained their vitality, and proving that the germs of fermentation and putrefaction are very widely diffused."—*Scientific American.*

THE USE OF SOLUTIONS OF SOLUBLE CHLORIDES FOR LAYING DUST IN THOROUGHFARES.

MR. J. W. COOPER has read to the British Association a paper on this subject, in which he stated that in Liverpool, in 1869, Bold Street, Church Street, and Lord Street were watered with salts during the month of July: the Report of the results was very favourable, and the experiments had been continued this year. It was difficult to prove the economy resulting from the use of chloride over a limited area; and the Westminster Board of Works, after observing the effect produced at Whitehall and Knightsbridge, resolved to extend the experiment throughout their entire district, comprising an area of 250,000 square yards. As soon as the area was extended the economy in labour and water was at once made evident. By using one ton and a half of chlorides per day, costing 3*l.* 15*s.*, the labour of ten cart horses and men, costing 4*l.* 10*s.* (at 9*s.* per horse, cart, and man), can be dispensed with, and consequently the quantity of water they would spread is saved also, viz. 350 loads of 250 gallons each, which at 10*d.* per 1,000 gallons (a fair average price for water in London) would amount to 3*l.* 12*s.* 11*d.* in addition to the 15*s.* per day saved in labour; thus showing a clear gain of 4*l.* 7*s.* 11*d.* after paying for the salts. An effective method of remedying the evils arising from organic matter deposited on public thoroughfares is becoming daily a serious matter for consideration with sanitary authorities, as much sickness is believed to arise from the malaria emanating from this source. The disgusting odour and dangerous nature of some of the deodorising agents used was strong evidence that they would not be used at all if the necessity for some determined action to prevent the spread of contagion and disease was not fully recognised. The deliquescent chloride of aluminium, recently introduced to public notice by Professor Gamgee, seemed to meet all the requirements needed in the antiseptic of the future. It was non-poisonous and free from any odour; it prevented decomposition, and arrested it when commenced. It absorbed noxious gases resulting from putrefaction, and destroyed parasites and germs. It was also not to be surpassed as a precipitant and deodoriser of sewage, and was only one-third the cost of carbolic acid. Mr. Cooper proposed to add a sufficient percentage of this chloride to the salts for street watering, and thereby afford a means of thoroughly and effectually purifying public thoroughfares without additional cost to the ratepayers, the value of the water and labour saved being more than sufficient to pay for the use of the chlorides.

FERMENTATION.

Mr. J. Bell has read to the Chemical Society a paper "On Fermentation." A series of experiments was instituted to determine some important questions regarding the process of fermentation. From among the manifold results obtained in these investigations the following may be mentioned: (*a*) Addition of glucose to fermenting liquids, especially to the juice of the grape, is advantageous, inasmuch as it assists to exhaust the fermentative element, and thus imparts to the fermented liquid a greater keeping power; (*b*) Each ferment has its favourite soil.—The President, taking occasion of this paper, gave a brief *resumé* of the present state of knowledge of the yeast plant. Though called a "plant," the yeast organism appears in all its functions rather animal than vegetable; the products it secretes are less complicated than those it takes in; it absorbs no heat, like the plants, nor does it require light for its vital process. Alluding then to Liebig's recent memoir on fermentation, Dr. Williamson observed that that distinguished chemist had entirely dropped his ancient notions about the nature of fermentation.

ORGANIC MATTER IN WATER.

Dr. Ketsch has found that a few drops of sewer-water mixed with a cane-sugar solution set up a kind of fermentation, and when examining part of the turbid liquid under the microscope he found it full of small spherical cells. Boiling does not destroy the vitality of these organisms; filtration through a good bed of animal charcoal is the only effectual mode of removing them; but it is necessary to air the charcoal from time to time, else it loses its purifying property, and leaves the water after filtration as bad as before.

ORGANIC MATTERS CONTAINED IN AIR.

Mr. Chapman has stated to the Chemical Society that by drawing air through a filter of finely-powdered pumice-stone spread on wire-gauze and moistened, he collected the organic particles suspended in the atmosphere; and having washed the pumice with boiling water, he converted the nitrogen of the organic matter, now in the water, into ammonia by means of potassic hydrate and potassic permanganate, and estimated the ammonia with the Nessler test. In the air of crowded rooms volatile bases were found as well as fixed organic particles; the latter can be removed by filtration through cotton wool, but the volatile bases pass through this medium. Mr. Chapman also communicated some new reactions of alcohols. One of them is the conversion of amylic alcohol, which rotates the polarized ray into such which does not rotate it. The transformation is effectuated by repeatedly distilling the non-rotating liquid from soda, calcic cloride, &c. Amylic alcohol, as commonly obtained, is always a mixture of these two kinds. The other reaction is the formation of water when alcohol vapour passes over sodic hydrate treated to about 230 degrees C.

THE SOLFATARA WATERS.

Signor de Luca, in some important remarks on the chemical and therapeutical properties of the thermal waters of the *Solfatara* of Pozzuoli, states that he has discovered the presence of arsenic in these waters; and from experiments he has made he believes that they will become of considerable importance when applied, as he suggests, to various industrial manufactures.

SOLUTION OF METAL.

A **Solvent** for a Metal as a metal is a novelty which has been discovered by Professor Seely, who tells us that liquid ammonia will dissolve sodium, and that the solution, on evaporation, leaves the metal in the metallic state.

METALLINE.

Nature speaks of an invention which aims at the entire abolition of oils and all other lubricating material for boxes, slides, and every condition of motion where metallic friction is to be overcome or expected. It is claimed that such a result has been fully achieved, and there are engines now running with this material, which the proprietors aver have worked to complete satisfaction for weeks and months. It is the work of a scientific and practical gentleman, well known both in America and in Europe, who has spent a great many years in the study of physical forces and their effects, with especial reference to metals. The exact nature of the present invention cannot be given, for the reason that patents are being sought for in several countries in Europe, and any clear description of the materials and processes would be likely to defeat that end. It may, however, be said, in a general way, that the discovery—which has received the name of Metalline—consists of such combinations and manipulations of various metallic substances, as to make a surface on which the ordinary axles, cranks, pins, slides, &c., of iron, steel, brass, or any other metal, will run with much less friction, without heat that comes within the slightest possibility of danger, and without increase (in fact an actual decrease is claimed) of the motive power used. These, briefly, are the claims, and the inventor refers to a large number of trustworthy gentlemen who have examined and tried the thing, and speak from actual knowledge.

HYDROGENIUM AMALGAM.

Our knowledge of the compounds which Mr. Graham's Hydrogenium forms with metals has been increased by Mr. Loew, of New York, who has produced an amalgam of hydrogenium and mercury. This may be made by placing some zinc amalgam in a solution of bichloride of platinum, taking care to keep the mixture cool. A spongy mass then forms on the surface of the zinc amalgam, which is the compound of hydrogenium and mercury. It has mixed with it, however, some finely-divided platinum, for in the action which takes place the bichloride is decomposed, oxychloride of zinc is formed, and the platinum reduced. As regards the properties of the hydrogenium amalgam, we are only told that when spread in the air the temperature rises and water is formed, a result obviously due to the presence of the finely-divided platinum. Speculating on the constitution of hydrogenium, Mr. Loew reminds us of Mr. Graham's comparison with the active modification of oxygen-ozone, and claims for hydrogenium a similar constitution. Then, if we represent the three modifications of oxygen by the following formulæ:—

[O]	[O O]	[O O] O
Antozone.	Common oxygen.	Ozone.

the three modifications of hydrogen will be similarly expressed:—

[H]	[H H]	[H H] H
Nascent hydrogen.	Common hydrogen.	Hydrogenium.

Granting the analogies, we doubt whether this is a view with which Mr. Graham would have coincided.—*Mechanics' Magazine.*

PLATINUM.

M. Schutzenberger, Director of the Chemical Laboratory at the Sorbonne, has discovered three new combinations of Platinum volatizing at 302° Fahrenheit: the first of these consists of two equivalents of oxide of carbon, and two of chlorure of platinum; the second and third are produced by the addition respectively of one and two additional equivalents of oxide of carbon.—*Athenæum.*

DECOMPOSITION OF WATER BY IRON.

M. **St. Clair Deville**, in his continued researches on the action of steam on iron, confirms his previous declaration that, in the decomposition of water by iron, hydrogen obeys all the laws of hygrometry, at least within the limits of 150 degrees to 1,600 degrees Centigrade; thus, when a given volume of water is made to act on iron, the tension of the hydrogen is always the same under the same temperature, whatever be the quantity of the iron. This is in direct contradiction to Berthollet's theory of mass, long accepted, but never put to actual proof. Whether the quantity of iron heated to redness be 10, 100, or 1,000 grammes, M. Deville finds the tension invariable, which appears scientifically logical.

RUST OF IRON.

Dr. **Calvert**, in a communication to the Chemical Society, gives some very useful information on the Rusting of Iron. Rust is mainly sesqui-oxide of iron, and it has always been supposed that the active agents in producing it are moisture and oxygen. It seems, however, from Dr. Calvert's experiments that carbonic acid must be associated with these to produce any considerable amount of oxidation. In dry oxygen iron does not rust at all; in moist oxygen but little and seldom; but in a mixture of moist carbonic acid and oxygen iron and steel rust very rapidly. In like manner a piece of bright iron placed in water saturated with oxygen rusts very little; but if carbonic is present as well oxidation goes on so fast that a dark precipitate is produced in a very short time. Curiously enough, bright iron placed in a solution of caustic or carbonated alkali does not rust at all. These facts show that the points to be attended to in the preservation of iron from rust are the exclusion of carbonic acid and moisture, two indications which may be very easily fulfilled.—*Mechanics' Magazine.*

ON VANADIUM BY PROFESSOR ROSCOE.

This metal was discovered in 1830, by Sesström, but more fully examined by Berzelius, and it is to the investigations of the great Swede that we owe almost all our acquaintance with the Chemistry of Vanadium. He found its atomic weight = 68·5, and gave to its three oxides the formulæ—VO, VO_2, VO_3. Some years afterwards, Rammelsberg observed that the mineral Vanadinite, a double salt of lead vanadate and lead chloride, is isomorph with apatite and with mimetesite, the former containing phosophoric, the latter arsenic acid. This crystallographic analogy would have led to conclude that the oxide of vanadium in the vanadinite has the formula $V\,O_5$, agreeing with the corresponding oxides of phosphorus and arsenic, P_2O_5 and As_2O_5. But according to Berzelius the oxide in question must be represented by $V\,O_3$. It was evident that there was here an exception to the law of isomorphism, or else Berzelius's views are erroneous. Professor Roscoe having come into possession of a plentiful source of vanadium (this source is a by-product obtained in the preparation of cobalt from the copper-bearing beds of the lower Keuper-Sandstone of the Trias at Alderley Edge, in Cheshire) determined to clear up the doubt existing about this question. He soon found the key to the enigma; he proved that the substance supposed by Berzelius to be vanadium is not a metal, but an oxide, and that the true atomic weight of the metal is 51·3. Thus the vanadic acid, VO_3, of Berzelius really becomes V_2O_5 corresponding to P_2O_5 and As_2O_5. The lecturer went on to demonstrate that the character of the vanadates bears out the analogy of vanadic with phosphoric and arsenic acid, and that vanadium, hitherto standing in no definite relation to other elements, must be regarded as a member of the well-known Triad class of elementary substances, comprising nitrogen, phosphorus, boron, arsenic, antimony, and bismuth.—*Proceedings of the Chemical Society.*

SIEMENS'S STEEL.

AMONG the articles exhibited at Sir Edward Sabine's conversazione were Mr. C. W. Siemens's Specimens of Steel, which have not yet had the notice they so well deserve; they represented the metal in various forms and conditions, and in different stages of manufacture. The process by which this steel is produced may be briefly stated thus:—Good hæmatite ore and spathic ore are mixed and treated with carbonaceous materials, by which their total or partial reduction into metallic iron is effected. This metallic iron is then subjected to very intense heat on the open hearth of a Siemens' regenerative gas-furnace, and in certain given quantities, or series of instalments, is dropped into a bath of cast iron previously prepared in the furnace. This operation is continued until the requisite degree of decarbonization is arrived at; and manganese is added in the form of ore or of Spiegeleisen. The quantity of molten metal thus produced in one charge is about four tons: it is tipped into a ladle, and poured into iron moulds in the usual way, and forms steel of the highest quality. To those acquainted with the ordinary way of making steel the superiority of this process will be manifest, while as regards cost it effects a great saving. One ton of steel ingots may be produced with a ton and a half of cheap small coal. The ordinary Sheffield process requires from five to six tons of fuel for one ton of steel. The new process is now actively carried on at the Landore-Siemens Steel Company's Works, near Swansea.—*Athenæum.*

ASSAYS OF GOLD AND SILVER.

MR. TOOKEY has communicated to the Chemical Society a paper "on the Manipulation of Assays of Gold and Silver Bullion.' To effectuate a saving of time, the author proceeds in the following manner: each bullion is placed in a platinum tube closed at one end with a perforated plate; several of such tubes are supported by a porcelain tile, which for that purpose is provided with circular holes; the entire arrangement is then immersed in nitric acid and proceeded with as if a single bullion had to be treated. In the case of the assay of silver, a contrivance, similar in principle, is employed to do away with the hammering and brushing of the buttons after they have been detached from the cupels; the solvent used here is hydrochloric acid.

FLAME APPARATUS.

A PAPER giving a description of a simple apparatus for watching the flame from a Bessemer converter has been read to the American Association for the Advancement of Science, by Mr. J. M. Silliman. The apparatus consists of three coloured glasses, two of light yellow, and one of deep blue. Seen through these the flame at the commencement of the operation is of a deep crimson colour and extends but a short distance. After a time it extends and becomes of a paler colour and has a purplish border, but there is always a deep crimson band at the base of the flame. At the second stage there is a crimson wreath at the top of the flame, and the purple border changes to green. This change is considered to be due to manganese. At the moment of decarbonisation all colour disappears, and only a stream of non-illuminating gas issues from the converter. The appearances in the spectroscope coincide entirely with those observed by means of this simple apparatus, which becomes a valuable instrument for watching the progress of the conversion.—*Mechanics' Magazine.*

TURPENTINE AND CAMPHINE.

A NEW French patent is for entirely removing the smell from turpentine, and so forming a superior kind of camphine. It is effected by rectifying turpentine over tannin, which is said, with how much truth we do not know, to remove all the resinous materials which give an offensive odour. So rectified, the turpentine can replace the best benzole used for cleansing, and gives a much better result.

CHANGES IN PETROLEUM.

ACCORDING to a writer named Gratowski solar light exercises a remarkable influence on petroleum oils. Exposed to light he states that the oils absorb oxygen and change it into ozone without themselves forming any chemical compound with the ozone, which remains at liberty in the oil and oxidises anything it comes in contact with. The oils, however, are greatly changed when they contain ozone; they burn with difficulty, it is said, and increase in density. If in corked bottles the corks decay from the action of the ozone. We do not believe much of the above; but if it be true it is quite right of the author to recommend that petroleum should be kept in metallic cans, or, if in glass bottles, be put in the dark.

CAUSE OF EXPLOSIONS.

A VERY curious and important fact—if, indeed, it is a fact—is mentioned by M. Jouglet, who states that nitro-glycerine and dynamite explode in contact with ozone. Ozone, as our readers are well aware, is only known in the diluted state, and it is highly important to ascertain what proportion of ozone in the air is sufficient to cause these substances to explode. Since they are commonly employed in situations, quarries in the open country for example, where, according to the meteorologists, ozone is tolerably certain to be found in the air, we must, unless M. Jouglet is contradicted, look on the use of dynamite even as highly dangerous. If the truth of the statement be established we have explained the cause of some explosions which have been called "spontaneous."—*Mechanics' Magazine.*

ARSENIC IN SEWAGE.

Nature remarks that in the report of the Royal Commission on Pollution of Rivers the presence of arsenic in the water and mud of rivers near alkali works is pointed out; and it is also stated that the London sewage at Barking contains as much as ·004 of arsenic in 100,000 parts.

A NEW POISON.

IN a paper addressed to the Academy of Sciences, MM. Rebutau and Peyre have given a description of a plant which grows in the vicinity of the French settlement of Gaboon, and which the natives call *m'boondoo.* They had gathered it themselves in a moist soil in the neighbourhood of the river Como, at thirty leagues from the frontier. It is very difficult to procure, because the sorcerers of the country conceal the plant with great care from the profane, so that its properties are still in a great measure a mystery. The roots vary in thickness between three centimetres and one (a centimetre is four-tenths of an inch); their length varies between fifty and seventy. Their rind, whether fresh or dry, is reddish outside and a vivid red within; the root itself is mere hard wood. Both this and its bark are exceedingly bitter; their infusions, even when considerably diluted, still retain this taste to a high degree. They yield abundant precipitates even when treated either by iodide of potassium or phospho-molybdic acid; whence it may be concluded that they contain at least one, if not several alkaloids. The effects produced upon animals may be briefly stated as follows:—When a very weak dose is injected under the skin of a frog, the poison only produces constraint in the limbs, a sort of paralysis, which prevents the creature from leaping easily, and makes it crawl like a toad. But notwithstanding, the substance does not act like woorali, since the power of muscular contraction is not impaired when the operator excites the nerves. With a dose of three milligr., the extract, introduced under the skin, after causing the constraint alluded to, brings on tetanic convulsions, when the animal is touched, or the table on which it lies is struck with the hand or otherwise. Nevertheless, the creature does not become rigid as when poisoned with strychnine; and if it has received a weak dose, it will recover in the course of a few hours when put into water. Hence it may be concluded that the poison is rapidly eliminated from the animal economy.—*Galignani.*

ADULTERATION OF RICE-FLOUR.

Rice flour is said to be often adulterated with wheaten, rye, and maize flour, as well as cheaper materials. The detection of these depends upon the recognition of cerealine, or, if pea or some other meals have been used, leguminosin. Picric acid has the property of precipitating these substances, and thus becomes an important agent in the detection of the above adulterations. It is employed in the following way:—The suspected flour is first digested with cold water for an hour or two, the mixture being frequently stirred. Then the liquor is quickly filtered, and the filtrate is gradually mixed with about an equal volume of a cold saturated solution of picric acid. Any precipitate produced shows that the rice flour has been adulterated with one of the above-named substances. Two per cent. of most of them may be detected in this way.

HOW TO PREVENT LEAD POISONING IN WATER.

Various substitutes for lead piping have been tried, but all are more or less open to objection. The substitute recommended by Mr. A. Gordon is that invented by Mr. Haines, C.E. It consists of a leaden pipe with an internal pipe of block tin, both having been previously pressed together so as to form a homogeneous whole. By this process the piping retains all the flexibility of lead, while the inner tube of tin is strong and thick enough to prevent any access of water to the exterior leaden pipe.

VEGETABLE OILS AND MALARIA.

Prof. Mantegazza has communicated to the Institute of Sciences at Milan the results of experiments, from which he is led to conclude that Vegetable Oils have a preservative effect against Malaria. He finds that flowers exhale ozone in large quantities, and of a quality superior to that produced in other ways, the exhalation being most abundant during sunshine, and least at night. It is to be inferred from this that the cultivation of aromatic plants and the use of vegetable scents would be particularly beneficial in marshy districts, or in localities where the air from any cause acquires a noxious quality; and the Professor recommends that labourers who work in swamps and rice-fields, should carry about them a small quantity of spirits of turpentine, or some other powerful aromatic. There are places enough in the broad plains of Lombardy, where the value of this recommendation might be tested.—*Athenæum.*

IODINE FROM SALTPETRE.

Professor Wagner states that the manufacture of Iodine from Chili Saltpetre already amounts to 30,000 lb. per annum. The method invented by Thiercelin for its reclamation from the crude material is as follows:—The mother liquors resulting from the manufacture of saltpetre are treated with a mixture of sulphurous acid and sulphite of soda, in proper proportion, and the iodine will be precipitated as a black powder. The precipitated iodine is put into earthen jars, on the bottom of which are layers of quartz sand, fine at the top and coarse at the bottom; from this it is removed by earthen spoons into boxes lined with gypsum, and a greater part of the water thus removed. It is sometimes sold in this impure state, or further purified by sublimation.

SULPHATES OF ALCOHOL RADICLES.

Mr. E. T. Chapman has read to the Chemical Society, a paper on "The Production of the Sulphates of the Alcohol Radicles from the Nitrites by the Action of Sulphurous Acid." When sulphurous acid gas is passed into nitrite of amyl it is rapidly absorbed. The nitrite changes in colour from yellow to green, from green to blue; it then begins to effervesce, and at the same time becomes hot and boils violently. Careful observation showed that the reaction consisted in the replacement of two atoms of nitric oxide by one of sulphurous acid. The resulting liquid compound had, therefore, the composition of neutral sulphate of amyl. It readily breaks up into amylic alcohol and sulphuric acid by boiling with water, and, by long standing, even with cold water. Treated with strong hydriodic acid, it yields sulphuretted hydrogen, water, iodine, and amylic iodide; potassic bichromate and sulphuric acid cause it to yield valerianic acid. Sulphurous acid and butylic nitrite react upon one another in a manner analogous to that of amylic nitrite, but the resulting product is even more unstable. Sulphurous acid and nitrite of ethyl do not readily act upon each other; at least, not at the common temperature. Mr. Chapman then proceeded to the theoretical considerations which are suggested by the above facts. Are these compounds, properly speaking, sulphates of alcohol radicles, or only isomeric bodies with them? The reaction of the amyl compound with water is very different from that of sulphate of ethyl under similar circumstances; it does not, when boiled with water, form an acid analogous to isothionic acid, but splits up into sulphuric acid and amylic alcohol. This would suggest a different linking of the molecules.

POISONING BY BLAST FURNACE GASES.

Dr. Percy has addressed to the *Times* the following communication:—"In the *Times* of to-day (July 9) it is reported that four men have been killed at ironworks in North Staffordshire by what is termed 'Waste Gas from the Blast Furnaces.' The poisonous ingredient of that gas is carbonic oxide, and the inhalation of it in very small quantity, whether pure or mixed with common air, rapidly destroys life. I have collected and published several cases of fatal poisoning from that cause at ironworks, foreign as well as British. A few years ago the engineer of the Dowlais Ironworks was suffocated in his office by the escape of this gas from an adjoining culvert. It is important that the managers of such works should be acquainted with its highly poisonous nature, and take every precaution to prevent their workmen from being exposed to its influence. As the use of the waste gas from our blast furnaces for heating steam boilers, mine kilns, &c., is extending daily, it is to be feared that deaths from its inhalation may become more frequent than hitherto, unless those who deal with it are fully instructed concerning its action on man." Dr. Percy writes "with the hope of communicating such instruction as widely and as quickly as possible."

CARBONIC ACID.

Dr. R. W. Richardson has communicated to the British Association, "New Physiological Researches on the Effects of Carbonic Acid." The observations made were new, in that they related to the direct action of carbonic acid on animal and vegetable fluids, and they were interesting equally to the zoologist and botanist as to the anatomist. The author first demonstrated from a specimen the result of subjecting a vegetable alkaline infusion to the action of carbonic acid under pressure. The result was a thick fluid substance which resembled the fluid which exudes as gums from some trees. When this fluid was gently dried it became a semi-solid substance, which yielded elastic fibres, and somewhat resembled conachone. This observation had led the author to study the effect of carbonic acid on albumen, serum of blood, blood itself, bronchial secretion, and other organic fluids. When the serum of blood was thus treated with carbonic acid under pressure and gentle warmth, 96′ Fahrenheit, the colloidal part was separated; but when the blood, with the fibrine removed from it, was treated, there was no direct separation, the blood corpuscles seeming for a time to engage the gas by the condensation of it. But blood containing fibrine, and held fluid by tribasic phosphate of soda, was at once coogulated by the acid. The bronchial secretion is thickened by carbonic acid, and a tenacious fluid is obtained resembling the secretion which occurs in asthma and bronchitis, while secretions on serous surfaces are thickened and rendered adhesive. After detail of many other facts, Dr. Richardson concluded by showing what bearing this subject had of a practical kind. In the first place, the research had relation to the question of elasticity of organic substances; and, secondly, on the direct action of carbonic acid on the production of vegetable juices. But the greatest interest concentrated on the relation of the research to some of the diseases of the animal body. Thus, in instances, where the temperature of the body is raised and the production of carbonic acid is excessive, the blood on the right side of the heart has its fibrine often precipitated; and in many other cases fibrinous or albuminous exuded fluids are solidified, as is the case in croup. The author, in the course of his paper, explained how rapidly blood charged with carbonic acid absorbed oxygen when exposed to that gas; and he held, that carbonic acid in the venous blood was as essential to the process of respiration as was the oxygen in the pulmonary organs.

MANUFACTURE OF CHLORINE.

MR. WALTER WELDON has read to the British Association a paper on his process for the Manufacture of Chlorine, which was first made public in a paper read by him before the meeting at Exeter last year. Up to that time the vast quantity of chlorine required for the manufacture of bleaching powder was obtained by the re-action of hydrochloric acid on native peroxide of manganese. The acid solution of chloride of maganese, which is a residual product of this re-action, was thrown away to the extreme pollution of the river in the districts in which the manufacture of manganese was carried on. Mr. Weldon, after long continued devotion of time, labour, and money, has perfected a process by which the manganese in this solution is recovered, and is then made to serve for the liberation of chlorine from hydrochloric acid, over and over again without limit. When his paper was read in 1869, the new method was only in use at two places, and in them almost as an experiment. He was now able to put on record that it is in actual operation at ten works in this country; that, with the exception of a few of the smallest, every British manufacturer of chlorine has taken out a license for its use, and is erecting the necessary plant, that the principal continental manufacturers have done the same, and that large plants have been completed, or are in course of completion, both in France and Germany. In view of this great influence upon a large and important industry, the President of the Section had made special reference to Mr. Weldon's address, and had suggested to him the production of a paper in which all the details relating to it should be fully set forth. Into these details we need not enter; and it is sufficient to say that Mr. Weldon effects his object by causing the chloride of manganese to be decomposed by hydrate of lime, thus producing hydrated protoxide of manganese, which he converts into proxide by causing streams of atmospheric air to be forced through a fluid mixture of the protoxide with water. In this state of minute division, the protoxide absorbs oxygen from the air, and is converted into peroxide. It is found essential that not only a sufficient proportion of lime be employed to precipitate the oxide; but that a sufficient excess should be employed to form with it a compound which Mr. Weldon designates manganite of calcium.

CHLORAL EXPERIMENTS.

M. **Liebreich** has made a series of experiments with Chloral on animals. He gave a dose of it to a rabbit, and the animal died. To another he gave strychnine nitrate, and it died too; to a third he gave the same dose of both substances which had before caused death, and found that the poisons neutralised one another, and the rabbit survived.

METHYL COMPOUNDS.

Dr. **Richardson** has read to the British Association an important Report on Methyl Compounds, dealing with details that were only technical, but with principles of universal importance. With some small aid from the funds of the Association, Dr. Richardson has for some years carried on a series of investigations into the uses of various ethers and alcohols in medicine and surgery; and he was this year able to point to new remedies, the fruits of his labours, that have won and promise to hold a high place among the agents employed for the relief of pain and the cure of disease. He finds that it is becoming possible to predict the action of new compounds with great exactness from their chemical composition; and also, by modifying composition, to remove sources of inconvenience or of danger. By this line of work he hopes to arrive ultimately at an agent that wlll supersede chloroform and its analogues, and that will suspend sensation without danger to life. As a step in this direction he announced the discovery of "tri-ethylic ether," a new substance which had already been used as an anæsthetic, and from which excellent results might be expected.

THE BAKERIAN LECTURE.

The Bakerian Lecture announces a discovery of the first importance. Dr. Andrews, its author, has established the fact that the gaseous and liquid states of matter are continuous. His experiments have chiefly been made upon carbonic acid, confined in fine glass tubes, and subjected to various pressures up to that of 110 atmospheres; they show that from carbonic acid as a perfect gas to carbonic acid as a perfect liquid, the transition may be accomplished as a continuous process, and that the gas and liquid are only distant stages of a long series of continuous physical changes. The ordinary gaseous and liquid states are, in short, only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption of continuity.

OXYGEN GAS.

THE Municipal Council of Paris has authorised Messrs. Tessie du Motay and Co. to lay down on the Boulevard des Italiens pipes for the oxygen gas which they have succeeded in producing at a low price—30 centimes the cubic metre. It was proposed to renew the experiments for the system of oxhydric gas-lighting which were made in January and February, 1868, in the Court of the Tuileries, at the request and to the satisfaction of the Emperor. According to the Report of the inventors and promoters a saving of 50 per cent. would be effected by Parisian consumers. From a description by Professor Morton of the works at New York, where oxygen gas is manufactured on a large scale, we learn that they consist of retort-houses, engine-rooms, store-house, pumps for compressing gas in cylinders, and a gas-holder of 26,000 cubic feet capacity. The process is carried on as follows:—About 700 lb. of manganate of soda are placed in the retort, and heated to the requisite degree; super-heated steam from a boiler is then admitted for about ten minutes. Two equivalents of the manganate of soda and two of water react upon each other, the water combines with the soda of the manganate to form a hydrate of soda, the manganic acid is converted into sesquioxide of magnanese, containing only half the proportion of oxygen, and the other half of the oxygen passes off in the free state. At the conclusion of this part of the process the steam is shut off, and the superheated air is admitted for about 15 minutes, whereupon the sesquioxide combines with more oxygen from the air, and is reconverted into manganic acid, which again combines with soda. The retorts in each furnace are charged with 700 lb. of permanganate of soda, and by the consumption of two chaldrons of coke, and with the labour of three men, 25,000 cubic feet of oxygen are made per day. It is now sold at 2½d. per cubic foot, compressed in reservoirs up to a pressure of 250 lb. to the square inch. The gas is of excellent quality, and very pure.—*Mechanics' Magazine.*

NITROUS OXYDE GAS.

DR. THUDICHUM has addressed to the *Times* the following proposition, in order to alleviate the sufferings caused by the War:—

"The wounded soldiers are the greatest sufferers, and all possible efforts ought to be made to reduce the sum of pain to which, by surgical operations and dressings, they are necessarily subjected. Chloroform is largely used for this purpose, but its application meets with difficulties in many cases. Thus, the mere excitement of the wounded soldier is frequently so great that, for fear of choking, it cannot be applied at all; in other cases it produces sickness, which continues not rarely for hours after its application, and compromises the welfare of the patient. Its action is of such a kind that, practically, it is only applied for long and severe operations, rarely for slight ones, and never in that most painful and oft-repeated process, the dressing of wounds.

"All the advantages of chloroform, to the exclusion of the disadvantages just mentioned, are possessed by nitrous oxyde gas. It has no smell, produces quickly, in four or five full inspirations, a perfect anæsthesia, in which all operations can be performed without causing pain, and hardly a minute after the cessation of its inhalation its influence on the patient has entirely disappeared. It never produces choking or sickness, and there has never been a case of death under its influence.

"The marvellous effect of this gas was originally discovered by Sir Humphry Davy, but was not appreciated by the scientific world, owing to the wanton ridicule cast upon it by the short-sightedness of Gay-Lussac, and of several chemists following in his wake. It is the indubitable and great merit of British dentists to have again discovered the pain-killing effect of nitrous oxyde, and to have made its use for the relief of suffering a matter of daily and easy practice.

"A bulky gas could not be transported with the necessary facility, and therefore its use remained limited to institutions. But industry seized the processes and the gas was brought into a compressed form. This compression is now carried to fluidification. Nitrous oxyde is sold as a fluid in little iron flasks, of which each, hardly bigger than a wine bottle without the neck, evolves 100 gallons of gas. The production of this fluid nitrous oxyde is now a branch of industry carried on by the aid of steam power, erected specially and exclusively for this purpose, and yet the supply is hardly equal to the demand.

"Now, from my experience in war surgery and in the application of anæsthetics, and from the inquiries which I have instituted and the experiments which I have made relating to this nitrous oxyde, I have come to the conviction that this agent would be most useful in the military hospitals of the Continent, not only in primary operations, but also in the frequent painful dressings. There is less difficulty in its administration than in that of chloroform, and all surgeons would easily and quickly be able to appreciate and use it.

"I, therefore, propose that a portion of the funds which I have no doubt your generous appeal will cause to come forth abundantly should be applied to the purchase of, say, 1,000 bottles of his pain-destroying fluid, and of 50 inhaling mouthpieces, and that these should be forwarded to the hospitals abroad as quickly as they can be obtained. The experiment should be made on this scale to begin with. The discoveries of the gas, of its properties, and of its application in surgery are exclusively English, and the processes for its fluidification or 'coercion' are worthy examples of English mechanics. The gift would, therefore, be doubly graceful, as being both invaluable and the product of national genius and ingenuity, and would be applied with joy by the surgeons, and received with blessings by the stricken warriors."

Dr. Kidd has also addressed the following letter to the above journal:—

"The wounded in the French villages are suffering inconceivable misery and pain while doctors differ as to the special shape the relief of such pain may assume. But surely at least it would be well for those benevolent persons who may have an opportunity of assisting to know that they can do no harm, but an infinity of good, by sending nourishing meat extracts, chloroform, and that admirable new agent for procuring sleep and cessation of pain—hydrate of chloral. The latter is not unlike pulverised sugar. As much as goes on a shilling produces, in the midst of the most harassing agony from bullets or fragments of bullets pressing on nerves, &c., the most refreshing and delicious sleep, far superior to anything from opium. The objection to nitrous oxyde is that none of the surgeons on the field know how to administer it. The London dentists are in sore trouble and long debate as to its explosibility. So it is kept in iron bottles covered with cloth. But a nurse with an ordinary carpet bag well stocked with chloroform and chloral (not lint or tourniquets, seldom wanted) would be indeed an angel of charity going about from day to day among the field hospitals.'

NOXIOUS GASES IN WELLS.

THE loss of life by Noxious Gas in a Well, we are assured by a correspondent of the *Times*, is preventible by the adoption of the following very simple means:—Take some pieces of carpet, or common sacks, and make them up into a loose bundle, nearly as large as the area of the well. Enclose in it a brick to give weight, and attach to the bundle a rope of sufficient length to reach to the bottom of the well. Throw this bundle down the well, and haul it up again as quickly as possible. Repeat this operation rapidly for ten minutes, and the atmosphere of the well will become quite innoxious, as may be proved by letting down a lighted candle. The bundle carries before it a quantity of fresh air from the surface, and this displaces foul air from the bottom. This simple precaution should always be taken when there is any suspicion of foul air in a well, before allowing men to descend into it.—William Gossage, Widnes Soapery, near Warrington.

ATMOSPHERIC OZONE.

A COMMUNICATION has been read to the Chemical Society, on "Atmospheric Ozone," by Dr. Moffat. The results given in this paper were deduced from observations extending over a period of twenty years. By tables it was shown that the maximum of ozone takes place with the conditions of the equatorial current of the atmosphere, and that the minimum occurs with those of the polar current. The author stated that the quantity of ozone is greater in the night than in the day; that it varies with the season of the year, and that it is in maximum quantity with thunderstorms, the aurora, the zodiacal light, halos, hail, snow and sleet, when the readings of the barometer are decreasing, and that it is in minimum quantity with these phenomena when the readings of the barometer are increasing. He also stated that ozone was sometimes in maximum quantity and at others in minimum quantity with fog according to the meteorological process by which the fog is formed. Dr. Moffat named the supposed natural sources of atmospheric ozone; and he explained experiments he had performed, the results of which showed that ozone is not formed by the electrolytic action of the sunbeam upon vegetable essences, as stated by some authors, turpentine being an exception. The author views phosphorescence as the chief source of ozone; and tabulated results of observations on phosphorescence in connection with atmospheric conditions extending over a period of eight years were exhibited, by which it appeared that periods of phosphorescence and ozone occur with the conditions of the equatorial current of the atmosphere, and that periods of non-phosphorescence and no ozone take place with those of the polar current. Dr. Moffat had observations taken in the North Sea and on the North Atlantic; and results show that phosphorescence of the sea and the maximum quantity of ozone, and non-phosphorescence of the sea and the minimum of ozone take place under the above atmospheric conditions. Ozone, he said, is Nature's disinfectant; and when it is not available, it can be produced artificially. The action of phosphorence upon moist air he considers the readiest and cheapest way of forming it. Practically, he considers ozone observations very important. Medico-meteorological observations show that ozone is always in minimum quantity during cholera epidemics, and that cholera disappears on the setting in of the ozoniferous current of the atmosphere. Observations in the North Sea have found ozone test-papers very useful in foretelling weather; and the results of observations taken during four passages across the North Atlantic show that phosphorescence of the ocean and atmospheric ozone occur together; and that when the sea is not phosphorescent ozone is at zero; and, as a rule, if the sea be non-phosphorescent, and if ozone be at zero, with an equatorial air-current, the ship has entered either a polar sea-current or the "ice track," and icebergs are in near proximity.—*Athenæum.*

NEW ACIDS.

Mr. Perkin has read to the Chemical Society a paper "On some Derivatives of Anthracene," in which he communicates the discovery of two New Sulpho-Acids produced by the action of strong sulphuric acid on the chlorine and bromine substitution bodies of anthracene. These acids, called respectively disulphodichloroanthracenic, and disulphodibromanthracenic acid, form, with sodium, calcium, barium and strontium, well crystallizing salts. On treating the acids with oxidizing agents, or by boiling them with concentrated sulphuric acid, they exchange their chlorine or, respectively, bromine, for oxygen, and give thus rise to disulphoanthraquinonic acid. Remarkable is the power of fluorescence anthracene and most of its derivatives possess. Mr. Perkin illustrated this property by some interesting experiments.

PRESERVATION OF MEAT.

In Professor Gamgee's process for this purpose the chief agent employed is sulphurous acid; but in order to prevent this from flavouring the meat there is a preliminary exposure to carbonic oxide, by which the colouring matter of the blood and tissues is rendered able to resist the reducing or decomposing action of the acid. In the first place, the animals are killed by being made to breathe carbonic oxide, that is, by a process analogous to the administration of chloroform. Insensibility is quickly produced, and then the animal is bled, and the carcass dressed in the ordinary way. In a temperate climate it is left to cool and set spontaneously; but in a hot climate an artificial process of refrigeration is required. By this the carcass is reduced to about 50 deg. Fahrenheit; and it is then placed in an air-tight chamber, into which an atmosphere of mixed carbonic oxide and nitrogen is driven by a blower. In this chamber there is also a wooden case, containing charcoal, charged with sulphurous acid; and after the carcasses have been for a certain period exposed to the carbonic oxide and nitrogen alone, the lid of the case is drawn off by a thong passing through a stuffing box, and the charcoal gradually gives off its acid to the meat. The chamber is left undisturbed for 7 or 8 days in the case of sheep, 10 days for pigs, and 18 or 20 for bullocks. After this the door is opened, and the meat is taken out ready to be stored or packed. In hot climates not only do the carcasses require to be cooled at first, but a stream of cold brine from a refrigerator is kept flowing over the chambers during the whole of the process.

The expense of the plant and method is inconsiderable. In addition to the butchers required to kill and dress the animals, the largest establishment would only need one man to drive the refrigerating machine and blower, and one to attend to the charging of the charcoal. In England the cost of preserving amounts to two or three pence for a sheep, and to about a shilling for a bullock.—*Times.*

GLASS MANUFACTURE.

At the late meeting of the British Association at Liverpool, the Chemical Section formed themselves into an excursion party, which visited the works of the Union Plate-glass Company at St. Helen's, where the various operations were explained and illustrated. The melting by means of Siemens' regenerating furnace, the casting, annealing, grinding, and polishing, excited much interest among the excursionists. A very curious influence exerted by heat upon diamonds was brought to their attention. When a diamond is used to cut hot glass it will only last for one day, and it assumes a milky appearance. Diamonds in constant use for cutting cold glass last about three months. Each diamond costs from 35*s.* to 45*s.*, and is about three times the size of an ordinary glazier's diamond. Hot glass is cut more readily than cold glass.

A small work on glass-making has lately been published in France, and translated into English, in which scant justice is done to the superiority of English glass-making. (See *Curiosities of Glass-making*, by the late Mr. Apsley Pellatt, of the Falcon Glass Works.)

ARTIFICIAL PRECIOUS STONES.

M. Gaudin, who has devoted no inconsiderable proportion of his life to the production of these imitations, has recently exhibited some, of great beauty and also of some costliness, but still only shams. The basis of these imitations is alumina fused with silica by means of the oxy-hydrogen blowpipe. Alumina M. Gaudin has experimented with for many years, and has found that under the blowpipe it runs like water, boils, and at last evaporates just like water. He finds, therefore, that it is better to employ a little silica, which prevents the volatilization of the alumina. Moreover, a little of that substance is generally found in rubies, amethysts, emeralds, and sapphires, the stones he imitates. By this compound, and with the metallic oxide to give the proper colour, he has produced small specimens which have a tolerably perfect resemblance to the natural stones. They must, still, always be expensive, in comparison with larger and just as beautiful imitations exhibited at the same time by a manufacturer of optical glass. The production of these is simple and easy enough, and they will probably find a sale, while those of M. Gaudin, which will be much dearer and no more genuine, are likely to remain on his hands as chemical curiosities.—*Mechanics' Magazine.*

AN ORANGE DYE FROM ANTHRACENE.

There seems reason to believe that Anthracene will soon be made the source of as many dyes and colours as aniline and naphthaline. Dr. Bottger has been making experiments with that substance, and has discovered a beautiful orange-red compound, to which he has given the name of anthracene orange. It is directly derived from a nitro-compound, to which the discoverer provisionally assigns the formula $C_28 N_2 H_6 O_{12}$. The mode in which the compound is prepared is as follows:—One part, by weight, of pure sublimed anthrakinone is mixed with sixteen parts, by weight, of a mixture of equal volumes of sulphuric acid, specific gravity 1·84, and nitric acid, specific gravity 1·5. These are shaken together, and gently heated to about 40 deg. Centigrade. The anthrakinone dissolves in a few minutes; and then without loss of time the solution is poured in a thin stream into a considerable quantity of cold water. Here, the nitro-compound, mentioned above, deposits in the form of bulky flocculi of a yellowish-white colour. These are collected on a filter, and are afterwards put in a large porcelain dish with a reducing solution of protoxide of tin in potash or soda. In contact with this solution, the nitro-compound soon forms a beautiful emerald-green liquid, in which, on the application of heat, the anthracene orange separates, in shape of a cinnabar red powder. This is collected, washed with water, and dried; and can then be sublimed at about 260 deg. to 280 deg. Centigrade to yield magnificent pomegranate red feathery needles. The reducing solution, we are told, is best made by slowly pouring a fresh solution of proto-chloride of tin into a strong solution of caustic alkali, until the mixture becomes cloudy; then it is carefully filtered through a double paper, and is ready for use. The best solvents for anthracene orange are ether, acetic ether, acetone, chloroform, alcohol, and wood spirit. We are not yet told anything about the tinctorial properties of the new substance, with the chemical properties of which we shall not trouble our readers. As the directions for its preparation seem explicit, and not difficult to carry out, perhaps some of our readers may be disposed to experiment with the compound.—*Mechanics' Magazine.*

SOLUBLE GARNET.

It is stated that the new dye known as Soluble Garnet is coming largely into use on the Continent. It is the ammonia salt of isopurpuric acid, which is formed by the action of a metallic cyanide upon picric acid. The colours produced are like those obtained from archil, but more permanent. The dyeing is effected by the addition of an organic acid, such as tartaric or acetic acid, to the bath, mineral acids being excluded.—*Illustrated London News.*

ANILINE DYES.

We have on several occasions noticed the statements which had been made regarding the irritating action of some of the Aniline Dyes upon the skin, and which unless corrected, seemed likely greatly to curtail their use. M. Guyot now shows that these injurious effects are consequent wholly upon the impurity of the dyes employed, and that when the ingredients of the dyes are all chemically united and no foreign substance is present the dyes are quite innocuous. Thus, azuline, when pure, is harmless, but poisonous if it contain an excess of aniline. So also coraline, reckoned one of the chief offenders, is harmless when pure, but deleterious if it contain an excess of phenol. The remedy lies in the proper preparation and proper testing of the colours before dismissed into indiscriminate use; and the manufacture of these colours has now been so much improved that the complaints respecting them have nearly died out.—*Illustrated London News.*

NEW MARKING INKS.

A SIMPLE process is given in the *German Dyers' Journal*, which is said to produce a very deep and beautiful black on linen goods by means of aniline. The goods are first immersed in a bath consisting of a solution of acetate of aniline of 4 degrees Beaumè, to which is also added 4 per cent. of sal ammoniac, 4 per cent. of chlorate of potash, ½ per cent. of nitric acid, and 1 per cent. of sulphate of copper. The goods are then wrung out, and are taken moist to an oxidising chamber and exposed to moist warm air. After two or three days the black is fully developed, and the goods only require to be rinsed in a weak solution of ammonia, and finally in weak soap and water. The result is said to be an extraordinarily beautiful colour.

A German chemist, M. Kuhr, proposes a new method for marking linen. It is first saturated with a solution of 1 part of hypophosphite of soda and 2 parts of gum in 16 parts of distilled water. The linen is then ironed, and, when dry, you write upon it with a quill pen charged with a solution of 1 part of nitrate of silver and 6 parts of gum in 6 parts of distilled water.

COAL-TAR COLOURS.

PROFESSOR W. A. MILLER has delivered this year's Reade Lecture "On some Chemical Processes of forming Organic Compounds, with Illustrations from the Coal-tar Colours." The lecturer, while pointing out that chemists were as far as ever from being able to construct the fibres of a muscle or the cells of a plant, showed the great advance which has been made within the last few years in forming by chemical processes compounds which previously were only formed in processes connected with the actions of organised structures. The object of the lecture was to illustrate such chemical processes by the formation of various dyes from coal-tar, which the lecturer did by a series of experiments attractive from the extreme beauty of the colours produced as well as from the intrinsic scientific importance of the chemical changes indicated. The lecturer also traced and illustrated the various atomic substitutions which took place in the processes exhibited.

LOGWOOD AND PORT WINE.

A VERY easy way of detecting Logwood colour in wine has been published in France, which, if good for anything, will be useful in discovering the adulteration of port. We have only to moisten a strip of paper with a strong solution of neutral acetate of copper, and dip it into the suspected vinous fluid, which, if it contains logwood, will give a blue colour to the paper. If, however, the colour of the wine be the natural product of the grape the paper changes to a grey shade.

ARTIFICIAL ALIZARINE.

MR. PERKIN, in a paper read by him to the Chemical Society, gives the following history of the various researches which finally have led to the Artificial Production of Alizarine. Alizarine was first obtained from madder-root by Robiquet and Colin, and investigated by Schunk. Graebe and Liebermann, when submitting alizarine to the action of a reducing agent, found a hydro-carbon, which proved to be identical with anthracene from coal tar. Anthracene having thus been obtained from alizarine, it remained to produce alizarine from anthracene. For this purpose anthraquinone, an oxygenated derivative of anthracene, was treated with bromine, the bromine compound thus formed acted upon with caustic potash, and the potash salt produced by this treatment decomposed by hydric chloride. The product of these successive re-actions was alizarine. To turn this discovery to practical account the bromine required in the process must be replaced by the cheaper oil of vitriol. Artificial alizarine is entirely identical with the natural colouring matter. Both dissolve in caustic alkalies, forming violet solutious of the same tint: when applied to mordanted fabrics they produce exactly the same colours, bearing treatment with soap equally, and resisting in the same degree the influence of light Lastly, they show identical absorption bands in the spectrum. Still, as a substitute for madder, artificial alizarine has been objected to, on the ground that pure alizarine alone will not produce the madder colours, other colouring matters being yet required. But Schunk asserts that the final result of dyeing with madder is simply the combination of alizarine with the mordants employed. A good deal has also been said about the supply of anthracene; it must, however, be remembered that tar-distillers have as yet but little experience in separating this substance; Mr. Perkin believes that coal-tar contains considerable quantities of this hydro-carbon. No doubt the kind of coal used, as well as the temperature employed in the gas-works, influences the quality of the tar as a source of anthracene, but upon these points no definite information has yet been obtained. Mr. Perkin illustrated his lecture by exhibiting samples of fabrics dyed and printed with artificial alizarine, and also by projecting the spectra of some alizarine solutions on a screen. By producing alizarine from anthracene Graebe and Liebermann have given the first instance of the artificial formation of a vegetable colouring matter. The way by which the beautiful discovery has been arrived at proves, as the President pointed out, decisively the value of studying the molecular arrangements of chemical compounds.—*Athenæum.*

ARTIFICIAL ICE.

THERE is on exhibition at the Morgan Ironworks a machine which produces a most superior quality of Ice, perfectly clear, and more compact than ice made by natural freezing, and at a cost far less than the cheapest ice ever brought to the market. The Tellier machine consists of a steam pump for condensing the material used, a chamber for the reception of the material in its condensed form, and tanks which are filled with water to be converted into ice. The material in use now is liquid ammonia, known as spirits of hartshorn in the drug-stores. It is introduced into the machine from a cast-iron heater, vaporizes at 30 degrees below zero, and in this form is conducted into hollow iron plates, which are placed in a tank surrounded by water. The intense cold evolved rapidly freezes the water, and the vapour is returned in its circuit to the machine, whence it is pumped into a reservoir, and by means of pressure returned to a liquid form, in which condition it again returns to the machine, is again vaporized, and performs the same service to an unlimited extent. A machine will make 100 tons per day at a cost of $1 to $1 50c. per ton. Ice made by these machines is more durable than that made by nature, for this ice is frozen at a temperature from zero to 5 degrees below. The ice is as pure as the Croton, and none of the material used in its manufacture can come in contact with it, so that prejudice need not exist on that score. It can be made perfectly transparent by expelling the air from the water, or using distilled water, if such a course should be desirable. The pipes conducting and the chamber containing the material in use are so cold that they convert the moisture of the atmosphere into frost. By extending those pipes and carrying them through chambers containing articles to be preserved, refrigerators can be constructed on any scale desired, and cars, and even the holds of ships, can be converted into refrigerating chambers with the utmost ease. Meats can be brought fresh from Texas and landed in any Northern port in as good, if not better, condition than when killed and put on board. Meats can be purchased in that State for two cents a pound, and delivered in this city at a cost not exceeding a cent and a half per pound additional.—*New York Times.*

COD-LIVER OIL.

THE process of manufacturing the Cod-Liver Oil at Portugal Cove, Newfoundland, is described as follows in the *St. John's*

Telegraph:—The livers of the cod are sold by the fishermen to the manufacturer of the oil at the rate of 24c. a gallon. On the average it requires 2½ gallons of liver to produce a gallon of oil. The livers are first carefully washed, and must be "cooked" at once, while fresh. They are first put into a large tin boiler. This is plunged into a larger iron boiler filled with hot water, the water not being allowed to touch the livers, which are thus gently steamed till a quantity of oil is floating on the surface. This is dipped out and filtered through blanketing first; then twice afterwards it is filtered through bags of moleskin. From the last filtration it comes out of a beautiful crystalline transparency, and without any unpleasant smell or taste. The oil is now poured into sixty-gallon casks and forwarded to the exporting merchant. The refuse is placed under screw presses and the remainder of the oil extracted. This is not refined, but sold as common cod oil, and is used largely on railways and for lubricating machinery.

The cod-liver oil has gone up in price lately, owing to the immense demand for it in Europe. Last year 330 tuns of it were exported. Of the common cod oil, unrefined, 4,521 tuns were exported. So plentiful has been the catch of cod this year that in one factory 2,000 had been barrelled before the season was half through. The men who handle it get quite a liking for the oil. A little dog running about the premises laps it eagerly.

The secret of making good cod-liver oil lies in the application of the proper degree of heat; too much or too little will seriously injure the quality. Great attention to cleanliness is also necessary, the filtering-bags requiring to be washed thoroughly every day, and the troughs scrubbed out with great care. The rancid oil that is frequently met with is the produce of manufacturers who are careless about these matters. The best oil is made in the way above described; and all the many pretences about refining it and making it palatable, are, it is declared, mere moonshine, and either covers for adulterations, or such as deprive the oil of its medicinal properties.

IMPROVED MODE OF OBTAINING CASTOR OIL.

CAPT. H. A. DURANT, of Shepherd's Bush, proposes to treat Castor seeds in the following manner to obtain oil of a purer kind than that usually obtained:—The seeds to be treated are put into a shoot or feeder, which is so constructed and placed that as the seeds fall from it they come in contact with and are struck by blades or fans fixed on an axis having a rotary action communicated to it by motive power. By such percussive force the husks of the seeds are cracked and separated from the kernels, and the husks are winnowed or separated from the kernels of the seeds by ordinary blowers or fans attached to the husking apparatus. The oil is then expressed from the kernels in any ordinary way, and the oil so obtained is afterwards boiled in water, and the scum which rises to the surface is removed. The oil is allowed to cool and a quantity of bisulphuret of carbon is mixed with it to cleanse and clarify it. The proportion of bisulphuret of carbon to be used depends upon the quality of the oil, but generally about one gallon of the bisulphuret of carbon to about one gallon of the oil will be sufficient. After thus distilling the oil it is sometimes re-distilled upon concentrated potash, when sebacic acid and caprylic alcohol can be extracted as separate products, which may be turned to good account for useful and industrial purposes. The sebacic acid having a high melting point may be employed instead of stearic acid in the manufacture of candles, and if mixed with stearic acid the hardness or quality of the candles will be greatly improved, and they will resemble porcelain. By distilling castor oil upon concentrated potash, to obtain the sebacic acid and caprylic alcohol, a purer castor oil is procured with less time, trouble, and expense than is usual.—*Mechanics' Magazine.*

SNUFF-TAKING A PREVENTIVE FOR BRONCHITIS OR CONSUMPTION.

DR. JOHN MURRAY has presented to the British Medical Association a paper, in which he declares that he has seen the progress of Consumption arrested by practising the habit of snuff-taking, which is equally efficient in the case of Bronchitis, Dr. Murray says—"By titillating the lining membrane ot the nostrils, snuff acts as a powerful derivative and counter-irritant, and its use will tend to preserve the more important and susceptible pulmonary mucous membrane from evil. The sneezing which succeeds the unaccustomed application of the errhine, or agitates even an old and seasoned nose when a new titillant is tried, and the cough which is induced when, by chance, some of the lighter particles get into the throat, may be of some avail in effecting the elimination of albumenoid matter (the precursor of tubercle) from the lungs, ere it has had time to fill the air-cells and minute bronchi, and coagulate, in like manner, as sea-sickness is believed to do. The majority of medical men, when recovering from a common cold, will take a pinch in order to 'speed the going guest.' If good to expedite the departure of a cold, I have no hesitation in affirming that it will be better still, as an expedient in altogether preventing the catarrh, *e.g.*, if when on a journey you experience a succession of chills, in due time you may expect an attack of bronchitis, an infiltration of pneumonic, or tubercular plasma, or illness in some other form, each tending to reduce the powers of life, and consequently liable to set up consumption in those predisposed."

A PHOTOGRAPHIC DISCOVERY.

M. BAZIN has made a curious discovery, which merits the attention of photographers. The time required for the exposure of a plate is now very short, but if the author's observations be good for anything this time may be diminished at least one-third by adopting the plan to be described. It will excite astonishment to learn that the plan consists in admitting to the camera light which does not pass through the lens. M. Bazin makes four holes in the front of the camera, and fits them with glass coloured by a solution of carmine in ammonia, behind which he places another piece of unpolished glass. These holes are uncovered at the same time as the lens, so that the red light falls upon the plate simultaneously with the image through the lens. According to the statement of the author the blacks and high lights are by this means much softened and the half tones greatly improved. The same effect is said to be produced if the sensitised plate be exposed to red light either before or after the picture be taken; in the latter case, of course, before the image is developed. This is a matter on which it is impossible to express an opinion without experiments, and we must content ourselves by calling the notice of our photographic readers to the discovery. M. Bazin has tried other colours, but finds red to be the only one which gives satisfactory results.—*Mechanics' Magazine.*

CARBON PHOTOGRAPHS.

Mr. Pouncy, of Dorchester, whose method of producing Indestructible Carbon Photographs we have on several occasions referred to, has illustrated one part of his process at the photographic room in King's College. He takes a sheet of paper smeared on one side with a mixture of bitumen of Judea and of some suitable oil pigment. This paper is damped on the back with paraffine, and is then exposed for about twenty minutes beneath a negative to the action of light. After this has been done the paper is transferred to a tray containing turpentine, which dissolves away the whole of the bitumen and of the pigment mixed with it, except those portions upon which the light has acted, and which, by this action, are rendered insoluble. The picture is developed by the action of the turpentine in dissolving away the superfluous portions. The surface of the paper before it is covered with the pigment is rendered very smooth, and after the picture is taken it may be developed at any convenient time. The paper, moreover, will keep without being injured by the action of any moderate light. Mr. Pouncy also exhibited some photographs upon canvas similar to that used by painters, and which were obtained by applying the face of a paper photograph, obtained in the manner just described, to the face of the canvas, and passing both through the press. The pigment by this treatment adheres to the painted surface of the canvas, and the paper is damped and then removed. By another method the photographic image is impressed upon very thin paper, which is then coloured by broad masses of opaque colour behind. The picture is next pressed upon canvas as before; and finally, the paper is damped and removed, when the colours, shining through the detail of the photograph, give a coloured picture, which may then be finished by touching and glazing with transparent colours. Mr. Pouncy did not enter into a description of his system of photographic lithography on this occasion. Several gentlemen commercially interested in the photographic art attended with the view of ascertaining how far Mr. Pouncy's bitumenised paper would be likely to supersede the paper and processes commonly employed in photography, the product of which is a fugitive picture, instead of one as permanent as an engraving, and which Mr. Pouncy asserts his picture to be.

RAPIDITY OF PHOTOGRAPHIC ACTION.

It is estimated that 1-27,000th of a second is sufficient to fix the solar image, yet this is a long time in comparison with that in which photographs are taken by the electric light. The experiments of Sir Charles Wheatstone have shown that the duration of the illuminating spark does not exceed 1,000,000th of a second, yet a clear and distinct photographic image is obtained by a single electric discharge. By this means may be shown the real form of objects to which a deceptive appearance is given by their rapid movement. If a wheel on whose side any figure is drawn in conspicuous lines be made to rotate with the greatest possible velocity, the figure will present to the eye only a series of concentric bands of different shades. Let it now be photographed while in motion by the electric flash, and the wheel will appear stationary, with the figure perfectly well defined.

NEW LIGHT FOR PHOTOGRAPHERS.

A New Light for the use of photographers has been proposed by Dr. Van Monckhoven, which is produced by introducing a mixture of the carbonate and chloride of magnesia into the oxy-hydrogen flame. The lime light, though brilliant, is of a low actinic power, and the magnesium light, though of great actinic power, is unsteady. It is asserted that by the substitution now proposed the good qualities of both the lime and magnesium lights will be obtained without their defects.

EARLY PHOTOGRAPHY.

In the beginning of the present century, M. Charles, the great French physicist, in the course of his scientific lectures, used to produce, by the action of light on prepared paper, silhouettes, or black profiles. No record has hitherto been published of the method employed, a circumstance which has often been matter of regret. We recently learn that M. Bontemps has presented to the library of the French Academy of the Sciences the MSS.

of M. Charles. Amongst these papers are the MSS. of his lectures on physical sciences. It is not improbable that these papers may contain some notes of the means which he employed in producing the portraits in question, which, at the time, were the great attraction of his lectures. The historians of photography have always hoped to find in these writings the first step towards French photographic discovery. Wedgwood's experiments were brought before the Royal Society in 1802.—*Photographic News.*

LARGE LENS.

THE largest Photographic Portrait Lens ever made in this country is one of 10½ in. diameter, completed by Ross, and now in the possession of Mr. Mayall, of Regent Street. It is an achromatic lens of great power, and will take portraits of any size, from the smallest miniature up to very nearly life size. It is made of glass of the whitest description, and its size admits so large a volume of light that photographs covering a space of 10 in. by 12 in. may be done in eight seconds. The lens renders in the photograph all that is seen in the optical image, and this so truthfully that the coarseness and exaggeration belonging to large photographs taken with inferior lenses are altogether absent. In the open air groups of 15 to 20 persons (each face about the size of a sovereign, and the whole picture 24 in. by 24 in.) can be taken with the short exposure of 10 seconds. The cost of manufacturing the lens was upwards of 200*l*., but it may be said to be worth its weight in gold.

DETECTIVE PHOTOGRAPHY.

SOME years ago, several scientific men in the United States endeavoured to show that a photograph of the impression remaining upon the retina after death might prove a valuable aid in the detection of murder. The subject has been fully reinvestigated by M. Vernois, and he has proved that before the body is quite lifeless all power of sight has left the retina, and that therefore this plan is of no value.

CARBON IN STEEL.

MR. HERMAN has read to the Chemical Society a paper "On the Determination of Carbon in Steel." Several samples of steel were analysed according to different methods, with the view of ascertaining which of the usual processes for determining carbon in iron is the most advantageous. A large number of careful experiments led to the conclusion that the direct burning of the iron in a stream of oxygen is the most expeditious and accurate method.

Natural History.

ZOOLOGY.

MODIFICATIONS OF MANKIND.

Professor Huxley has read to the Ethnological Society a paper "On the chief Modifications of Mankind, and their Geographical Distribution." After explaining those physical characters which are of the greatest value in distinguishing the several modifications,—such as colour, character of hair, and form of skull,—the author proceeded to describe five distinct types of mankind: the *Australioid*, found in Australia, in the Dekhan, and formerly in the valley of the Nile; the *Negroid*, including the Negroes and Bushmen of Africa, and the Negritos of New Guinea, Tasmania, &c.; the *Xanthochroic*, distributed through Iceland, Eastern Britain, Scandinavia. North and Central Germany, and extending through Eastern Europe into Asia as far as North-western India, and found also in North Africa; the *Melanochroic*, located in an area situated between the Xanthochroic and Australioid peoples; and the *Mongoloid*, a large and somewhat ill-defined group occupying Central and Northern Asia, the two Americas, and Polynesia.

SUCCESSION AND CONTINUITY.

A paper has been read to the British Association, "On some of the more important Facts of Succession in relation to any Theory of Continuity," by Dr. Cobbold, who said that for several years past the Biological Section had permitted, if it had not actually encouraged, the reading of papers on the theory of natural selection. The facts he had selected for exposition were such as represented what might be termed the apparent chronology of the organic series, or, in other words, the ascertained times of the coming and flourishing of the larger animal groups. A true conception of what was or ought to be understood by the expression "equivalences"—botanical, zoological, or geological—lay at the basis of a correct appreciation of the significance of the records of animal, vegetable, or sedimentary rock distribution throughout all time. Further, he ventured to assert that the grandeur of the formative scheme of Nature, whether testifying to an evolutionary method of production or to a series of creative acts, few or many in number, could only be adequately realised by the naturalist whose powers of allocation and grouping enabled him to grasp the import of those relations. He then proceeded to deal with the facts of succession, describing the various known groups, and, glancing at the times of origin and succession of the placental mammals, saying the first thing that the record suggested was the rapidity with which the most divergent groups made their appearance. Of course, there was no real basis for an assumption of coeval creation. It might be held, on zoological grounds, that we ought not to separate men and monkeys, but retain them as one of the twelve under the ordinal title of primates. He adopted the division of the placental into twelve groups, not from any rigid belief as to their separate equivalences, but because they were not only sufficiently distinctive for practical purposes, and also formed on the whole perhaps the finest expression of grouping which science could at present afford. After dwelling at great length upon the succession of the various groups, he stated that as regarded the highest of all, the placental series, he would only say that, as he understood the doctrine, the strictest demand of the developement theory did not require, as was commonly supposed, a lineal descent as between bimana and quadrumana; but it was certainly held that either of these groups, as we now know them, might have been separately evolved from more generalised primatal types, the intermediary terms being possibly connected by a long antecedent and far more generalised common progenitor. In that connexion the most advanced evolutionist must own that the assumedly missing tertiary primatals constituted a great and natural bar to the popular acceptance of the theory of descent by natural selection. On the other hand, there was a multitude of considerations which seemed to him to outweigh all the data thrown into the anti-continuity side of the balance.

STONE IMPLEMENTS.

SIR JOHN LUBBOCK, F.R.S., has read to the British Association "Remarks on Stone Implements from Western Africa." Considering that at the present moment the great continent of Africa is, probably, the most backward in civilisation, it is somewhat remarkable how deficient it is in stone weapons; that being, no doubt, owing to the great abundance of sands containing iron, and the facility with which that metal is obtained. This infrequency and almost entire absence of stone implements has been alluded to on various occasions by those who have felt it to be a difficulty with respect to the fact of the use of stone having in all cases preceded the use of iron and other metals. But although implements of stone are of rare occurrence in Africa, still they are by no means altogether unknown. Some spearheads were exhibited to the meeting from the Cape of Good Hope. The first stone implements from that locality we owe to Mr. Busk. These were sent by Mr. Deal, the Inspector of Education in Cape Colony, and they are remarkably similar to the spearheads which are found in Europe and elsewhere. In Egypt, also, stone weapons of a very simple character have been found; but from Southern Africa nothing has been received that could be called an arrow-head. Sometimes small stone implements are called arrows which the author thought not worthy of the name.

The truth is, a savage is very careful indeed in the manner in which he manufactures his arrow-heads. It has probably taken him a day, or a day and a half, to get near his game; and it would be very provoking to him to miss his aim from any deficiency in the form of his weapon. It is, therefore, great economy of time on his part to devote a considerable portion of it to the manufacture of arrows which will be tolerably true. Therefore, perhaps, scarcely sufficient caution is used in calling small stone implements arrow-heads. Again, a very common type of stone implement found in Europe, the scraper, does not appear to be abundant in Africa; and the specimen from the Cape of Good Hope is the nearest approach to the type which has come from that part of the world, and yet it is not at all a typical specimen. Stone implements of rough flint have also been found in Mount Sinai, and a specimen was shown, found by Mr. Freeman, at Wady Ithm, in the Syrian district, on the road to Petra. But the specimens to which it was most desired to call attention have been sent over by Mr. Reade from Western Africa, that gentleman being engaged in scientific research in Africa at the expense of an enlightened merchant, Mr. Swanzy. It is true that implements of this character have been sent to Europe before, but they were very few, and did not attract much notice. These were obtained at some feet underground, in sections exposed by the river, near Accra. There are several interesting points in Mr. Reade's letter which accompanied them; one being the idea that these stones are thunderbolts. We know that is a notion which exists almost all over the world—from Western Europe to the far distant regions of Hindostan. That they may be employed as charms, and also as medicine, is a very general notion. The depth at which these stones were found must not be taken as evidence that they were of great antiquity; neither are the superstitious notions connected with them evidence in that direction. One of the axes from the African collection was put in contrast with a tray of other axes, from all parts of the world, in order that attention might be called to that which has indeed been commented on before, but yet which is of such interest that it cannot be repeated too often—the extreme similarity of these primitive implements. There were examples from New Zealand, North America, Chili, English, Irish, and German specimens, from Spain, British Guiana, South America, from the river Amazon and Australia. That common type, therefore, may truly be said to be found all over the world. Besides the ordinary type, there was a wedge-shaped, thick and very rounded form, not so widely distributed. A quartz pebble, which had a hole carefully drilled through it, had been used probably as an ornament. Considering the abundance of ores of iron in this African district, and the facility with which they could be smelted, and metal obtained, it is probable that these stone axes belong to a time before the natives of this place became acquainted with the art of smelting iron.

PHILOSOPHY OF RELIGION AMONG THE LOWER RACES OF MANKIND.

Mr. E. B. Tylor, in a paper read to the Ethnological Society, taking the doctrine of spiritual beings as the minimum definition of religion, the author described it as *Animism*, a term that fits with the theory put forward that the conception of the soul, as recognised by the Lower Races, is the starting-point of their Religious Philosophy. Such a soul, combining the ideas of ghost and vital principle, explains the phenomena of life, disease, dreams, visions, &c. This idea is extended to animals and inanimate objects, which are considered to have souls capable of appearing after their death or destruction. On the analogy of the body and soul the actions of nature are explained by the animistic theory as worked or controlled by soul-like spiritual beings. An immense number of these beings are held to be actually human souls or manes. To such spiritual beings are ascribed the phenomena of disease, especially epilepsy and mania. Similar in nature, though different in function. are the spirits of trees, rivers, &c. Thence the savage polytheist rises to expanded conceptions of greater deities—sun, moon, heaven, earth, &c. At an early period he separates the functions of favourable and harmful spirits, causes of good and evil, and thus Dualism is rooted deeply in the religions of the lower races. The culminating conception of a Supreme Deity is well known to many of these races. Their conceptions of souls and spirits, having on the one hand their connection with the evidence of the senses and the action of nature, and on the other hand showing close relation with the philosophy of civilised religions, furnish a most important key to the development of animism in the world at large.

ARCHITECTURE OF THE HUMAN BODY.—THE JAW.

Dr. Humphry, in a recent lecture, explained that the movements of the lower jaw are governed by the action of a very large and powerful muscle, which covers a very large portion of the side of the skull; it reaches to the temples, and at its upper part spreads upwards over the side of the head like a fan. It is the presence of this muscle which makes it unpleasant work to eat a hard biscuit with a tight hat on the head. In the skeletons of human beings and all other animals except the badger, when the soft ligaments and parts joining the bones together have decayed away, the bones always fall asunder, but the lower jaw of the badger is so hinged in the skull of the animal that it does not fall out of its place when all the soft parts of the head have decayed away. When speaking of the chest he said that the fact that the place of the heart is more to the left of the centre of the chest than to the right, seems to have a tendency to drive more blood to the right side and right arm than would otherwise be the case, so this may have something to do with right-handedness.

ARCHITECTURE OF THE HUMAN BODY—THE HAND.

Dr. Humphry, in his lecture, has remarked on Gainsborough's celebrated picture, "The Blue Boy," as a wonderful example of the works of the Human Hand. He said that there is no very great structural difference between the hand of man and that of other animals, its power being derived from the directing brain. He then commented on the great and free range of motion possessed by the hand and arm, referring to the admirable joints at the shoulder and elbow, and the provision made for rotation, pronation, and supination. He next described the structure of the fingers and thumb, each having its peculiar structure and independent movement, yet all enabled to combine for clasping and similar actions; and he especially noticed the thumb as the most powerful, it being sometimes termed half the hand. Among his illustrations the Professor referred to the natural position of the pen in writing, and the consequent practice of writing with thick down strokes and thin up strokes, and from left to right, adopted by the most civilised nations. He also commented on the number of the human digits as the foundation of our numerical system; and, after comparing the hoofs of various animals—including the horse, ass, ox, two-toed sloth, rhinoceros, hippopotamus, and elephant—he suggested that their differences were due to the cleavage or budding of a central digit, and that the number of digits in man was the result of the development of the middle finger by division. He next described the provision made in the hand for sensation and touch by the little cushions placed at our fingers' end, containing nerves, and the fine broad nails evolved from the cuticle to give firmness. In regard to sensation, he adverted to the shaking of hands as a mark of friendship, and the pressure of the hand as a sign of affection in life and in the dying hour. In conclusion, the Professor made some remarks on the difference between the right hand and left, and expressed his opinion that the use of the former in preference to the latter is based upon natural causes, which he explained.

ARCHITECTURE OF THE HUMAN BODY.—THE FOOT.

Dr. Humphry, in his sixth and concluding lecture delivered at the Royal Institution, began by commenting on the great importance of our feet, as the foundation of the human edifice, and on the combination in them of strength and lightness, whereby they are so well adapted for our firm support and easy locomotion. In commencing the description of parts of the foot, he adverted to the size as being strictly proportional to our height, and he then contrasted its structure with that of the hand, which is formed for more free and independent movements. The remarkable works sometimes executed by the foot alone, such as those by a painter at Antwerp, the Professor referred to the lateral action of the toes, rather than to capabilities resembling those of the fingers; and after pointing out the peculiarities which had led to the classification of the extremities of animals into hands, paws, and feet, he said that man alone possesses a perfect foot, and he alone is able to plant it firmly upon the ground. The Professor next considered the various parts of the foot, dilating on the beautiful arch and the formation of the heel, and the provision made for the elasticity required in the movements of walking, ascending, and descending; and after stating that it is not natural for us to alight on our feet vertically, said that when this occurs by accident serious results often ensue. He then alluded to the beautiful apparatus required for the motions of the feet, and the admirably harmonious combination of muscles, ligaments, and nerves which give to our limbs and feet so much of an automatic character. After saying that a perfect foot is one of nature's rarest gifts, and very difficult to maintain, the Professor adverted to its deformities and diseases, some of which proceed from the unnatural conical shape given to our shoes; and he especially alluded to the consequences of wearing high-heeled boots, which deprive us of one of our distinctive advantages over animals, and which, by throwing all our body out of equilibrium, produces the ungraceful "Grecian bend." In speaking of the ankle joint, he said that it is the finest piece of mechanism in the human body, and has to perform the hardest work.

TERRESTRIAL AND MARINE FAUNA OF MAGELLAN AND WESTERN PATAGONIA.

Dr. R. B. Cunningham has read to the British Association a paper beginning with the Mammalia: The existence of the puma, two species of ox, a mephitis or skunk, an otter, the sea-lion, the fur-seal, the guanaca, a species of deer, and a variety of rodents, were recorded from the Strait. No marsupials were met with in Patagonia proper, but a small opossum, not uncommon in the neighbourhood of Concepcion, occurred in the island of Chiloe. The Raptores comprised two species of vulturidæ, the turkey-bustard, the condor, seven species of falconidæ, and four of strigidæ. Among the more interesting of the remaining land-birds were a humming-bird, a paroquet, and two species of woodpecker. But one true reptile, a small lizard, was recorded from the Strait of Magellan; but on the west coast of Patagonia, amphibia were found as far south as lat. 51°, and these consisted of two species: one, the *Hylades leptopus*, discovered by Mr. Darwin at Valdivia; and the other the type of a new genus named by Dr. Günther *Namophryne.* About twenty species of fish were obtained. Reference was made to two new genera, Mamea (family Lycedidæ) and Psammobatis (family Raiadæ). The Invertebrata were then passed in review, and the more interesting ferns remarked on. Regarded as a whole, the fauna of the Strait and Western Patagonia appears to belong to the Chilian type.

MAMMALS FROM CHINA AND JAPAN.

MR. R. SWINHOE has communicated to the Zoological Society a catalogue of the Mammals of South China and Formosa, with notes upon the various species that he had observed during his numerous travels in those countries; a second communication from Mr. R. Swinhoe contained a list of birds collected by Mr. C. Collingwood during a cruise in the seas of China and Japan, with notes by the collector. The collection was stated to embrace examples of thirty-three species, amongst which were several of rare occurrence.—*Athenæum.*

NEW ANIMAL FROM QUEENSLAND.

A COMMUNICATION to the Zoological Society has been received from Mr. G. Krefft, containing the description of a new and remarkable animal, allied to Lepidosiren, recently discovered in the fresh-waters of Queensland; Mr. Krefft referred this animal to the genus Ceratodus of Agassiz, proposing to call it *Ceratodus Forsteri,* after Mr. W. Forster, its discoverer.—*Ibid.*

BRANCHIAL SYSTEM.

AT the Académie des Sciences M. Dumeril has read a paper upon some ancillary organs of the Branchial System found in some species of the Ray tribe. These consist of folds of membrane supported by cartilage and they are situated at the bottom of the mouth. Their function is to retain the water and thus aid in the complete oxygenation of the blood.—*Ibid.*

BRAIN OF EDENTATA.

M. CAMILLE DARESTE has made some new observations on the brains of Edentata, and points out that they support his theory; that the extent of convolution of the brain in the species of a natural group is in the ratio of the total size of the animal. Thus he finds that the convolutions in the brain of the Mylodon and the Megatherium are far more developed than in the brains of the comparatively diminutive sloths of our day.—*Ibid.*

PEDIGREE OF THE HORSE.

PROFESSOR HUXLEY, at the Royal Institution, has given a discourse on the palæontological evidences of the progressive development of the Horse from inferior ancestors. He began by stating that the theory of the evolution of species, as propounded by Mr. Darwin, after much opposition, had become the leading doctrine maintained by the chief scientific men in the world. The doctrine of the conservation of force and that of evolution were the two scientific marks of the nineteenth century—the former being firmly established, the other not quite so surely. The evolution theory, he said, rests upon three pillars—the origin of living matter from matter not living, the production of new species from a common stock by natural selection, and the historical evidence of animals succeeding each other in accordance with the principles of the theory. The evidence regarding the first point is still very unsatisfactory, and that of the second not yet perfectly conclusive; but the third, for a long time the weakest, had become the strongest, and is now, as it were, the headstone of the corner, since the rocks have revealed to us various transitional forms between past and present animals. After adverting to the lecture on Feb. 7, 1868, in which he demonstrated, from palæontological evidence, that ages ago creatures had existed who were neither perfect birds nor reptiles, but partook of the nature of both, and that the former had been probably evolved out of the latter, he described the mode of obtaining good conclusive historical evidence, and then proceeded to the subject of his discourse. In the first place, he commented on the beautiful symmetry of the structure of the horse as being specially adapted for special work and the summit of perfection as a running-machine. He then noticed some of the special peculiarities which distinguish it from ordinary quadrupeds—these being the fore limb, the hind limb, and the teeth. The ulna and radius, the two distinct bones in the arm of man and most quadrupeds, in the horse are fused together, and he possesses only one of the five digits—the middle one, with its nail, being represented by the hoof, all the rest being rudimentary, in the form of slender splints. A similar conformation occurs in the hind limb; and the teeth are very complex, comprising ridges, pillars, bone, and cement, admirably adapted for the mastication of suitable food. In the embryo horse the remains of the ulna and the rudiments of the lost toes are more distinct; and horses have been sometimes born with extra toes, of which a specimen is to be seen at the College of Surgeons, and in a living South American pony now at the Victoria Docks. According to the theory of evolution, the Professor said that the facts suggest that the horse has gradually attained his perfection as a running-machine by the abolition of useless parts and the development of others; and this notion has been supported by palæontological evidence. The remains of the horse and ass abound all over Europe in geological strata of very remote antiquity, the latter part of the miocene epoch, long before any indications of man appear; and Dr. Falconer, while exploring the Sewalik Hills, in the Himalayas, found that in the deposits of the middle part of that epoch the place of the horse had been taken by another genus named the hipparion, or "little horse," and in the lowest miocene and upper eocene strata by another creature, the anchitherium or hippatherium.

Professor Huxley then referred to diagrams representing the anatomical specialities of these creatures, which led him to the conclusion that they constitute the true lineage of modern horses, the hipparion being the intermediate stage between the two, this opinion being founded on the evidence of the rudimentary toes, more distinct ulna and radius, and less complex tooth structure. Having expressed his conviction that an authentic pedigree of the horse had been so far established, the Professor referred to the probability that the plagiolophus, a three-toed creature partaking of equine and ruminant types, found in the upper and middle eocene strata, was a still earlier ancestor, and that this was also a descendant from a five-toed family. In conclusion, the Professor said that, if this doctrine had been made out for the horse, it must hold good for all cases. Especial reference was made to the researches of M. Gaudrey in Attica.

THE ANGORA.

The Sydney Exhibition had a pen of Angora goats, which obtained a great deal of attention. The *Sydney Herald* says:—"We hope to see further interest taken in angoras, as it appears now only one enterprising colonist can be found who is really prosecuting their culture. There are vast tracts of miserable country which might be turned to profitable account by depasturing goats. The hair is sold in England at prices varying from 1*s*. 6*d*. to 3*s*. and 4*s*. per pound, and the fine quality is much used in the manufacture of silks for mixing purposes, thereby strengthening the fabric; also in the manufacture of the Cashmere shawls, so generally admired. The angora goat is extremely hardy, and very prolific. The kids make excellent mutton, and their management is easy. They require shearing twice a year, and yield about 2lbs. a head at every clip. The well-bred angora is covered with fine silky hair all over the body, sides of the head, and back, and in addition is generally judged by the absence of kempy or coarse hair. The fleeces of young animals are the most valuable in quality. The pen exhibited showed considerable merit, especially the ewe, but the fleece shows evident mismanagement in its culture. The skins properly dressed make beautiful mats for carriages, and the leather is superior to common goatskin."

THE MOTION OF THE WINGS OF BIRDS.

The remarkable discovery made by Mr. Pettigrew in 1867, that the wings of all animals are twisted upon themselves, and that they twist and untwist during their action, has quite recently been confirmed by Professor Marey, of the College of France. This gentleman has experimentally demonstrated the character of the air-path of the vibrating wing, and has shown, as Mr. Pettigrew has already proved, that the wing during its oscillations describes a figure of 8 track, which, in horizontal motion, becomes converted into a wove track. Mr. Pettigrew's discovery and Professor Marey's demonstrations are of great interest to aëronauts.

THE GREBE.

A FINE specimen of the Grebe was shot near the confluence of the Wye and Severn, about two miles from Chepstow, in February last. The grebe is classed by Linnæus among the genus *Colymbus*, of which the guillemots and divers are likewise families. The grebes are without a tail, have a strong, straight-pointed bill, a long neck, with body depressed and thickly covered with soft, shining plumage; the wings are very short, and appear incapable of sustaining any lengthened flight. The principal characteristics of the grebe, according to Linnæus, are the lobate feet, consisting of four toes each. The plumage of the breast is well known, being extensively used and in great request as an article of female attire. This bird is rarely seen in England, and the above (so far as is known) is the only instance of its having been met with in this neighbourhood.

THE GOLDEN ORIOLE.

SEVERAL Golden Orioles having lately been observed and killed in the Land's End district, has induced a Correspondent of the *Times* to plead for the preservation of this beautiful bird, which the writer has had many opportunities of observing in a wild state in France, and of testifying to the beauty of its plumage, the richness of its song, and the utility of its habits.

The golden oriole comes to us from the Continent every year as a summer visitant, and generally makes its appearance in small parties about the end of April or beginning of May. In size nearly equalling the thrush, the male bird may be recognised at once by his bright yellow body and black wings; the female is more sombre in appearance, her prevailing tints being green and grey.

The song is wonderfully clear and musical, reminding one occasionally of the blackbird, and yet differing from it remarkably. The nest is unlike that of any other bird which builds in this country, being placed in the fork of a bough, the two twigs which comprise the fork passing on either side of the nest, which is, as it were, lashed to them with long grass, and depends between them. The eggs, as large as those of the thrush, are pure white, with black spots on the larger end. During the time the young are in the nest the old birds feed them incessantly with insects, and a male oriole has been seen in an oak wood feeding his mate as she sat upon her eggs with caterpillars which he brought to her at intervals from the neighbouring oaks.

Now, as the writer doubts not whatever that the golden oriole which visits us so regularly every Spring would rest here if unmolested, it is a matter of great regret that it should not be allowed to do so. Apart from the beauty of its plumage and song, the good which a few pairs of this bird would do in ridding a plantation of caterpillars in the Spring should insure for it that protection which it deserves.

ORNITHOLOGICAL OUTRAGES.

THE *Proceedings of the Yorkshire Naturalists Club* contain an account of a number of rare birds shot in the neighbourhood of York during the past year. A pair of the Fulmar petrel, a bird common at St. Kilda, but rare on the English coast, appeared at Scarborough, perhaps trusting in Mr. Sykes's Act: they were soon at a bird-stuffer's shop. The turtle dove, which is rarely seen north of the Humber, was shot at Hunmanby. The merlin, the little tern, and other birds whose extinction seems imminent in England, make up the list. The addition of rare birds to collections is supposed to advance the study of natural history, but in reality only adds to our knowledge of skins. It is much to be wished that provincial ornithologists would do more in the way of observation and less in the way of making collections.—*Athenæum.*

THE VULTURINE GUINEA-FOWL.

IN the year 1834 the late Major-General Hardwicke described, at one of the meetings of the Zoological Society of London, a very remarkable species of Guinea-Fowl, peculiar in having the head and greater part of the neck devoid of feathers, and without any caruncles, and in the possession of long ornamental hackles surrounding the base of the neck and breast. The specimen described had been procured by Captain Probyn, in some part of Africa, and at that time belonged to the collection of the United Service Museum. It was subsequently figured by Mr. Gould, in his beautiful work called *Icones Avium.* For many years the vulturine guinea-fowl was only known to naturalists from this unique specimen; but recently, and since the eastern coast of Africa has been more thoroughly explored, it has been discovered that this bird is by no means uncommon on the southern part of the Somali coast, and in the adjacent parts of Continental Africa. Dr. John Kirk, the well-known companion of Dr. Livingstone in the Zambesi expedition, who has been lately resident at Zanzibar as Acting Consul, has communicated several notices upon this guinea-fowl to the Zoological Society of London, of which he is an active correspondent. In one of his letters he says that it seems to be common at Lamoo, a port situate on the east coast of Africa, in about 2 deg. S. lat. The officers of H.M.S. *Syria,* when lately there, saw several in the market, but used them for the table, not being aware of their great rarity. More recently, Dr. Kirk has succeeded in securing for the aviaries of the Society a living female of the species. This fine bird was procured at Brava, on the southern part of the Somali coast, just to the north of the Equator, and was conveyed, along with a collection of other animals presented to the Zoological Society by Dr. Kirk, by the steamer *Malta,* through the Suez Canal, to Marseilles, under the kind care of Captain Mackenzie.—*Illustrated London News.*

NEW PHEASANTS AND HORNBILLS.

THE collection of living Pheasants belonging to the Zoological Society of London has just been enriched by the arrival of fine examples of the males of two new species, of which Mr. Sclater has read a paper, whence we extract the following particulars:—

"In October 1869, Dr. T. C. Jerdon, the well-known Indian naturalist, addressed to me a letter from Shillong, a new sanitarium on the Khaysa Hills, in Upper Assam, stating that he had obtained in that neighbourhood a skin of a tragopan distinct from either of the well-known Indian species, but which he believed might be Temminck's tragopan, from China. He had also seen a living example of an Impeyan pheasant, from the Mishmi Hills, which he considered to be probably new to science; and this he proposed to call the Lophophorus Sclateri. This letter was accompanied by an inclosure upon the same subject, for publication in the *Ibis*. In a subsequent communication, Dr. Jerdon informed me that, in the interests of the Society, he had begged of Major Montagu, of the Bengal Staff Corps (the fortunate possessor of the new Impeyan) the living bird in question, and also an example of the so-called Temminck's tragopan, in the same gentleman's possession. These he had forwarded to Dr. Anderson for transmission to the Society. Dr. Jerdon likewise stated that, since he last wrote, having had an opportunity of consulting authorities, he had convinced himself that the tragopan was distinct from the Temminck's tragopan; and, in a notice sent to the *Journal of the Asiatic Society of Bengal*, he had proposed to call it Blyth's tragopan (Ceriornis Blythii). The new Impeyan is at once distinguishable from the well-known or common Impeyan pheasant of the Himalaya, as also from the more recently discovered Lhuys' Impeyan of Sechuen, from well-marked characters. The sides of the head are widely naked, and covered with bright blue skin. The top of the head is covered with short curly feathers, of a bright green; and there is no appearance at all of the remarkable crest, whence the genus Lophophora has derived its name; the general plumage is velvety black, glossed with green above, and a coppery hue on the nape and wings; the lower back and upper tail coverts are pure white, with some longitudinal black striped straight streaks. The tail feathers are dark chestnut, terminated with white. These latter characters readily distinguish the present bird from the two other known species of Impeyans; and there can be no doubt that it forms a third species of this splendid group of pheasants. Not less readily distinguishable from its congeners is the tragopan, which Dr. Jerdon has named Ceriornis Blythii or Blyth's tragopan. Amongst the described species of the genus it most nearly resembles Cabot's tragopan, being in the lower part of its middle of a nearly uniform colour, somewhat like that species, and not distinctly ocellated, as in the three other members of the genus. It is, however, to be recognised at first sight by the splendid golden-yellow of the naked face and throat."

The Hornbills are a family of birds which inhabit the tropics of Asia and Africa, dwelling in the deepest jungles and forests, and feeding principally upon ripe fruits. They are very remarkable for the large size and curious forms of their beaks, which vary much in the different species, and attain huge proportions in some of them. In most of them, also, the feet are very singularly formed, the three toes in front being joined together for some distance from the base, so that it is almost impossible for them to make much progress on the ground, while they are thus especially adapted for an arboreal life. For many years it was supposed to be almost impossible to keep these handsome and attractive birds in a living state in this country. But recently, the proper mode of treatment having been discovered, the Zoological Society of London has succeeded in introducing several of the largest and finest species of the group as permanent denizens of the aviaries in Regent's Park. Amongst those at present in the Society's gardens are particularly noticeable a pair of the large concave-casqued hornbills, which have now been in the collection six years, besides examples of several other ornamental species. To these an important addition has just been made in the shape of three hornbills. The large figure in front represents a white-faced male, the black female of the plait-billed hornbill (Buceros Plicatus), and a female of the slender hornbill (Buceros Gracilis). These three birds have lately arrived from Sumatra and Malacca, where they were taken as nestlings from the forest-trees in which they were bred in the previous summer.—*Illustrated London News*, where the above specimens are engraved.

THE SWALLOW.

A CORRESPONDENT of the *Times* writes:—"On the passage from China on board Her Majesty's ship *Donegal*, upon August 27th, when in 9 degrees north latitude, and 19 degrees west longitude, about 250 miles off Sierra Leone, I observed a flight of six Swallows flying about and resting on the ship. As there had been no strong winds to blow them off the land, I concluded they were *en route* from Africa to America, or *vice versâ*. On the 28th I caught one; he was in good condition, and voided a quantity of white natural coloured fæces, so apparently was not long from land; therefore I inferred that the party were crossing from Africa, that being the nearest coast, and I was confirmed in this opinion from my captive showing no signs of fatigue, such as swallows exhibit after a severe flight. I found the adventurous *voyageur* to be our mutual friend *Hirundo Rustica*, whose family is so familiar to English homes.

"They continued following and roosting upon the ship for several days and nights, during which time I watched them narrowly, as I was very curious to ascertain upon what they fed, there being no flies about the ship. They spent their time in 'hawking' over the waves, pretty much the same as they would on shore, but I never saw them touch the surface. On August 3rd curiosity got the better of humanity, and I killed one and held a *post mortem* on him. Very different indeed was he from the first one; he smelt like a sea bird, his tail was draggled and covered with greenish yellow fæces, his feathers were becoming rough, and he felt clammy and sticky, and a miasma of guano pervaded him.

"Upon August 4th the remainder of the flight had disappeared, having traversed with us a distance of 1,022 knots; when they left we were going 10 knots on a strong 'north-east trade,' and I have no doubt they reached America in 20 hours, as a trip of 1,300 miles is a mere bagatelle to birds able to fly 50 knots an hour easily, with a strong wind behind them; possibly instinct warned them to stay by the 'floating island' until it blew strong enough to waft them across the Atlantic.

"I see no reason why at sea they should not be supposed to eat the Ocean Fly and Crustacea, which must form the food of the petrel, a bird similar in shape and form and flight to the swallow. Many affirm that they cannot take flies on the water; but as not only myself but others have seen them do it frequently on ponds, that does not hold good, as surely they can do the same on the sea. I certainly did not see them do so in the neighbourhood of the ship, but what they did beyond that I cannot say.

"*Virgil* says:—

'Aut arguta lacus circumvolitavit hirundo,'

'The twittering swallow skims the dimpled lake;' but the brave and dashing way in which these tiny birds navigate the air and make long and rapid passages across the 'wide, wide ocean,' is worthy of the admiration of a nation of sailors."

A paper has been read to the Zoological Society by Mr. R. B. Sharpe, "On the Swallows (Hirundinidæ) of Africa:" thirty-eight species of swallows were enumerated; thirty were peculiar to the continent of Africa, and two to Madagascar and the adjacent islands; two species are common to India and Africa, and the remaining four are migratory throughout the Palæarctic and Ethiopian regions.

Professor Giebel, of Halle, has made a thorough investigation with regard to the food of the swallow. He examined the alimentary canal in forty-six full-grown birds and in seventy-three young ones. Of the latter, more than half had been fed on insects alone, the stomachs of the others contained, besides insects, a few fruit-stones.

RARE FISH.

PROFESSORS Panceri and De Sanctis have written an interesting paper on the anatomy of the rare fish, the *Cephaloptera Giorna*, entitled "Sopra Alcuni Organi della Cephaloptera Giorna." In their remarks upon the brain of this fish, they observe that it is not only to be placed in the first rank of the class of fishes, but that it is superior to the brain of reptiles, and assimilates itself to the brains of birds.

SALMON CULTURE.

THE operations for the artificial propagation of Salmon at the Stormontfield breeding-ponds have in 1870 been carried on with great vigour. The ponds have been stocked with about 465,000 salmon ova, which exceeds the number deposited in any former year by about 100,000. In consequence of the long-continued frost, the hatching process was somewhat retarded. The operations at Mr. Buckland's Museum of Economic Fish Culture, South Kensington, have so far been successful. Although on a much smaller scale than the Stormontfield ponds, thousands of fish are annually hatched by Mr. Buckland in the Horticultural Society's Gardens. This year the eggs deposited were in healthy condition, and within the past fortnight several have been hatched out. The varieties of ova which were deposited last year consist of salmon, trout, great lake trout from Lake Neufchâtel, American trout, and salmon from Nuningue. Upwards of 80,000 eggs of the great lake trout from Switzerland have been received during the past year by Mr. Buckland, and have been distributed by him to stock lakes and ornamental waters in various parts of England.

A MONSTER SALMON.

MR. BUCKLAND writes to the *Times* as follows:—" Mr. Charles, of Arabella-row, Pimlico, fishmonger, kindly sent for me this morning to examine the largest salmon of modern times. I have seen this magnificent fish weighed; he just touches the scale at 70 lb.; his length is 4 ft. 5 in.; girth. 2 ft 7-2 in. He was caught in the Tay by Mr. Alexander Speedie, the well-known tacksman of Perth. The capture of this grand fish proves the soundness of the doctrine I have always endeavoured to promulgate among salmon conservators—'Preserve your kelts.' These kelts when going down the river are worthless for food; they will, however, return from the sea bright as new silver, and excellent 'food for the people,' having cost nobody a sixpence for their keep, as in the sea they live upon sand-eels, lug-worms, and the fry of sea fish. Thus this fish (which probably went to the sea in February, 1868), now returns (as Mr. Charles has informed me) worth at wholesale price 9*l.* 12*s.* 6*d.*, or the price of three very good sheep. In 1851 the late Mr. Yarrell examined a fish in Mr. Charles's shop that weighed 68 lb.; but he was a Dutchman. I have been permitted to take a cast of this magnificent Tay fish. I hope shortly to place the cast in my 'Museum of Economic Fish Culture,' at the Horticultural Gardens, Kensington."

Mr. Buckland also describes another large salmon caught in the Thames, and which he saw at Gravesend. "This," he says, "is a true salmon—salmo salar; it weighed 23 lb., and measured 39 in. in length, and 22 in. in girth. It was caught on the 18th of April in a sprat net at ebb tide by a fisherman in the lower part of Gravesend Reach. This beautiful fish has but few of the black X marks upon the back; the cheeks and sides are unusually bright and opalescent. The general shape is rather elongated. The question arises as to whether this is a Thames-bred fish. It must have been hatched somewhere; the nearest salmon rivers to the Thames on the South are the Itchen, Test, and Avon, in Hants; and on the north the rivers falling into the Humber. I do not think this fish came from any of these rivers. I am afraid to venture a hope that it is one of the salmon which Mr. Pender and myself have been breeding and turning out for the Thames Angling Preservation Society during the last seven years. This may possibly be the case, except that its history in the grilse state is unknown. Finally, it may have come across the Channel from the Rhine, for it has the general appearance of a Dutch fish, except about the head. Anyhow, I am glad to be able to report its arrival in the Thames, as it is a good omen for the future salmonisation of this noble river, though, doubtless, it will be called by some (as its predecessor three years ago was profanely called), 'the annual nuisance.'"

MONSTER SCOTCH SALMON.

In one particular the Salmon season of 1870 in Scotland has been very remarkable. In no previous year have so many heavy fish been brought to land, and if the season has not been very productive in regard to the quantity of fish taken, it certainly has been remarkable in regard to the number of large fish which have been captured. The preservation of kelts has, no doubt, been the chief cause of the increase in monster fish. From the Tay district we learn that both loch and river have yielded an extraordinary number of large fish this year. Salmon ranging in weight from 26 lb. to 30 lb. have been very numerous, while the capture of salmon weighing upwards of 50 lb. has not by any means been an uncommon occurrence. In Mr. Buckland's Museum of Economic Fish Culture at South Kensington there is a cast of a salmon which was caught in the nets below Newburgh, in June last, which turned the scale at 70 lb.; while a gentleman landed in March last, with rod and line, on the Stanley water, a splendid salmon of 61 lb. Besides these monsters, fish of the following weights were taken in the Tay district this year:—55¾ lb., 55 lb., 52 lb., 50 lb., 48 lb., 42 lb., 39 lb., 38 lb., 36 lb., and several others, ranging from 30 lb. to 35 lb. Many of the net fisheries on the upper portions of the Tay suffered considerably from the drought. The middle and lower stations, however, did pretty well, and several of the tacksmen are reported to have had a successful season. The angling season on the Tay was one of the worst on record. During most of the year the water was very low, and although salmon were not scarce, they were very shy, and would not rise to the fly. On the Tweed the fishing, both by rods and nets, was very poor. As on most other rivers throughout the kingdom, want of water more than anything else was the chief cause of bad sport. A good number of large fish, ranging in weight from 30 lb. to 40 lb., were, however, taken in the Tweed during the past year. The accounts from the river Forth are more satisfactory; the season is reported to have been, on the whole, productive. The lower fishings all did well (some stations yielding more fish than in any former year), and although the summer fishing on the upper waters fell considerably below an average, the spring fishing was good. This river also produced some fine fish this year, the two largest weighing 56½ lb. and 50 lb. On the Dee and Don the season has been a good one.—*Abridged from the Times.*

THE *Echo du Luxembourg* states that the exportation of Frogs from that country to France has increased considerably of late. Upwards of 200,000 were sent in three weeks by one dealer, and on one day 30,000 were sent by the same person. They are sent principally to Rheims, Nancy, and Paris. A thousand frogs fetch 13 francs (10*s.* 5*d.*), and weigh 50 kil., or about 1 cwt. No duty is charged by the French custom-house on frogs. At Rheims, 25 pairs of frogs' legs can be bought for 60 centimes. The autumn and spring are the best times of the year for frogs.

CARP AND TOAD.

M. DUCHEMIN has discovered that the mortality which took place annually in early spring among the Carp in a French fish-pond was occasioned by Toads. An enormous toad gets upon the head of a carp, and sits there with its feet applied to the eyes of the fish. A fim, causing blindness, grows upon the eyes of the carp and part of its head, and death soon ensues. The same circumstance has been often seen in England.

AUSTRALIAN LEECHES.

THE *Melbourne Argus* states that a large consignment of Leeches went to England in April by the steamship Somersetshire. It appears that some parts of Australia abound with leeches, and those which frequent the Murray river have a good repute for biting freely and leaving no inflammatory wound or mark behind; they are said to rival the speckled leech of Northern Europe. Measures were taken some time ago by a Melbourne firm for the conservation of the Murray leeches; and their contracts with the fishermen in the Murray district for the past season exceeded half a million. But the intercolonial demand is almost equal to the supply. The leeches sent to England were packed in boxes of soft clay, made to resemble as much as possible the muddy bottom of the river which is their ordinary resort. It is said that the prime cost of leeches sold in Europe must exceed two millions sterling per annum.

TO DESTROY INSECTS.

It is proposed to use hypophosphoric acid in agriculture for the destruction of insects. M. Stanislas Martin especially advocates its use against the *Phylloxera vastatrix*, which is so injurious to the roots of vines.

NEW GENUS-ACARELLUS.

Professor Westwood has made to the Entomological Society some observations on minute Acari, found in the unopened buds of black currant-trees, and possessing only four legs, and another species which forms small pustules on the leaves of pear-trees; these, with a third form described some years since in France, he regarded as constituting a distinct tribe of the family Acaridæ, and must at all events be placed in a separate genus, for which he proposed the name Acarellus.

ZOOLOGICAL LEGENDS.

"When an erroneous notion is once put in the form of an illustration to a scientific work, the tenacity with which it remains unaltered is wonderful. No matter how absurd, it is copied over and over again. In Prof. Gervais's recent *Elémens de Zoologie*, a work intended to be an official school-book for France, there are surprising instances of this. In an illustration of the nidification of the flamingo, that bird is represented straddling on a tall, conical nest of mud. This is an old and often refuted fable. We have few observations on the incubation of flamingoes, but it is certain that, like all other birds, they sit upon their nests with their legs bent under their body, in which position the length of those limbs is no inconvenience whatever."

We quote the above from the *Athenæum*, wherein also is noticed the repetition by M. Sonrel's *Bottom of the Sea*, translated by Elihu Rich, the Zoological part of which is poor throughout, and often erroneous, "repeating the fable that the Paper Nautilus uses its dorsal arms as sails, and the arms are talked of as membranes, though any museum specimen would show them to be muscular. M. Sonrel fixes the number of teeth in sharks at 130, whereas they are by no means definite in number. The electric eel and the electric ray are called 'depositories of thunder'—a peculiarly unfortunate description; for, notwithstanding their powers of giving shocks, they do not even make a crackling sound; then the stories of the combat of the sword-fish and the whale, and that of a wounded cachalot disgorging a shark 16 feet long, are hard to swallow."

BOTANY.

ANIMAL AND PLANT LIFE CONTRASTED.

DR. MAXWELL T. MASTERS, in a lecture at the Royal Institution, considers nutrition, as showing that the most important difference between Plants and Animals consists in the latter being able to dissolve and digest in their tissues solid ingredients, while plants can assimilate food only in the liquid and gaseous states. Plants, however, can form albuminous matters from the constituents of air, water, and ammonia, while animals can do so only by feeding upon organic substances. The assimilation of gases by plants, Dr. Masters says, has only an approximate relation to respiration, and is really a process of digestion. Carbonic acid or dioxide, ammonia, and watery vapour, are absorbed by the green parts of plants under the influence of sunlight; the carbonic acid of the atmosphere being decomposed, the oxygen set free, and the carbon retained. This process is intimately connected with the presence of chlorophyll, the green colouring matter of plants, which possesses many analogies with the colouring matter of the blood of the higher animals, iron being a necessary element in both liquids. The respiration of plants, going on by day and night, resembles that of animals in all essential points; and though, in some respects, plants as well as animals render air impure, yet they in turn purify the air, through the power of liberating oxygen possessed by chlorophyll; while those plants or parts of plants that are not green compensate for their pollution of the atmosphere by acting as scavengers. The circulation in the lowest plants and animals was shown to be of the same nature, but to be widely different from plants in the higher animals, who possess a heart and a distinct circulatory system. Another marked distinction between animals and plants consists in the adaptation of different organs to fulfil the same functions being found in a much greater degree in plants; of this the tendrils of climbing plants are striking examples—these being sometimes modifications of the leaf, stem, flower-stalk, and even of the petals, yet fulfilling the same functions. Another distinctive peculiarity of plants is the development of bud structures, and especially of bud variations, termed "sports" by gardeners. Illustrations of these were referred to, and remarks were made by Dr. Masters on the causes assigned, such as the dissociation of hybrid characters, reversion to some ancestral state, or progression to some new type. He then alluded to grafting, stating that the effects of the stock on the scion and of the scion on the stock were greater and of more importance in plants that on any that has yet been observed in similar cases among animals, and referring to striking examples of grafting or hybridisation furnished him by Mr. W. Paul, Mr. Laing, and Mr. Wills. In conclusion, he alluded to the essential unity of the vital and physical forces, and to their dependence on One Supreme Intelligence.

MUSHROOMS TRUE AND FALSE.

An extract from a new book, *Every-day Objects*, descriptive of the means of recognising the true Mushroom from the false, the edible from the poisonous, will, we conceive, be useful:—"The true mushroom as it developes itself ruptures the ovoid wrapper, or vulva, leaving the remains entirely at the base of the pedicel, while in the false mushroom the *débris* of the vulva are found not only at the base of the pedicel, as in the real Agaric, but even upon the red surface of the pileus itself. These are the white irregular warts characteristic of the Amanita, but wholly wanting in the Agaricus. Then, there are two Amanitas—the *Amanita muscaria*, or 'fly agaric,' and the *Amanita amastica*, or, as the English botanists call it, *Agaricus Cæsareus*, the imperial mushroom." To this we would add the sweet, delicate odour of the edible mushroom, which contrasts with the scentless, dangerous fungi, or the poisonous cryptogam, possessing a dull, heavy smell. The inexperienced, we hold, should not risk their lives for the sake of this delicacy; but if the extract we have quoted be carefully observed, we consider there will be little danger in mistaking the true from the deleterious mushroom, and less liability to error with its consequent danger to life.—*Medical Press and Circular.*

TEA CULTIVATION IN INDIA.

The Cultivation of Tea in Eastern India commenced about 40 years ago, and originated in the discovery of the indigenous plant in Assam in 1830. Thence it was introduced into Cachar and Darjeeling, and so on into the hills of the north-west, where the first crop of tea obtained in 1843 in Kumaon was so successful as to lead to further extension of the Government plantations. When Lord Dalhousie visited Kangra in 1852 he authorised the establishment of an extensive plantation at Holton, which in 1860 produced 29,312 lb. of tea, that yielded an average of 2*s.* per lb. when sold by public auction, and 3*s.* 4½*d.* by private sale. This plantation has now passed into private hands, seedlings having been given from it gratuitously year by year. All the chief plantations now flourishing are situated in the lower slopes of the snowy range of Chumba, at elevations of from 2,500 ft. to 5,000 ft. above the sea. They are 19 in number, the area of the largest being 8,708 acres, the area actually under tea cultivation 2,635 acres. The gross aggregate produce in the season of 1868 was 241,332 lb. of tea, the average produce being 91·6 per acre, and the average price realised by sale 2*s.* 2*d.* per lb. The cost of production and manufacture on a plantation which produces about 190 lb. or 200 lb. per acre may be set down at 1*s.* per lb. The small area actually under cultivation is said to be a healthy sign, for the last official report remarks that "it is the too rapid formation of extensive unmanageable estates that has led in some measure to the disastrous results of tea cultivation in parts of Assam." The four markets for the sale of Kangra are the London, the local European, the local native, and the Central Asian markets, of which the fourth is by far the most profitable. Umritsur is the great mart for the tea supply of Upper India and Central Asia, and there is an easy route, *viâ* Jamoo and Cashmere and Ladakh, and the Eastern Provinces of Central Asia *viâ* Cabool, to the great Central Asian marts of Herat, Khiva, Bokhara, and Samarcand, and *viâ* Kurrachee to the ports in the Persian Gulf. There are only two Kangra plantations now in the possession of the Government, and these will be sold at a favourable opportunity, the experiment of inaugurating the cultivation of tea in India having been now fully accomplished.—*Times*.

THE COFFEE-PLANT.

THE leaves of the Coffee-Plant are now proposed as a substitute for tea. They are found to contain more caffeine than the coffee-berry, and in Sumatra the natives cultivate the plant for the leaves. When cultivated for the berry, the coffee-plant requires a certain elevation above the sea; but when cultivated for the leaves, it may be grown anywhere within the tropics where the soil is suitable.

CHINCHONA.

THE range of growth of this plant is being rapidly extended. During the Indian Mutiny the enormous price given for quinine at Bombay and elsewhere in that presidency proved the importance of cultivating the Chinchona plant in that country, and efforts in this direction have since been attended with remarkable success. A new variety, yielding a larger percentage of quinine than any species yet analysed, has been discovered by Mr. Broughton, the quinologist to the Madras Government; and it is said to have been raised from seeds collected in the Loxa district of the Andes. About 4,000 chinchona-trees have lately been planted in the island of St. Helena, and as the climate is specially favourable and the inhabitants skilful in the management of the trees, there is no reason why this place of call for many of our vessels should not, in this way, supplement usefully her somewhat scanty revenues. The epidemic at Mauritius in 1867 showed sufficiently the importance of cheapening quinine at home and abroad in every possible way.—*Lancet*.

MOTIONS OF PLANTS.

BONNET proved that if the under part of leaves be placed upwards the leaf will gradually turn back to its natural position. M. Duchartre has proved that the same phenomenon takes place with the caps of mushrooms. When they are compelled to grow their heads downwards, they form a sharp bend in the stem, a little below the cap, so as to turn the head up into its natural position. M. Duchartre remarks that this fact contradicts the theory which attributes the direction taken by the organs of plants to their weight.

THE SENSITIVE PLANT.

M. Bert has been making experiments with regard to the action of green light on the Sensitive Plant. In a few days this light has the effect of darkness, the plant ceases to be sensitive, and finally dies.—*Athenæum.*

THE VARNISH TREE.

The beautiful Black Varnish which is so much admired the world over is the production of a tree which grows wild in Japan —and China as well. It is cultivated in plantations, and is so much improved by the treatment it receives, that a cultivated tree affords three times more of this valuable product than the wild one. The tree has some resemblance to the ash, with leaves shaped like those of the laurel, of a light green colour, and feels downy to the touch. It is of no great beauty, but is valuable as the source of a very lucrative manufacture.

These trees are capable of supplying the varnish when they have attained the age of seven or eight years. The varnish is gathered in the following manner:—About the middle of summer a number of labourers proceed to the plantations of these trees, each furnished with a crooked knife and a large number of hollow shells, larger than oyster shells. With their knives they make many incisions in the bark of the trees, about two inches in length, and under each incision they force the edge of the shell, which easily penetrates the soft bark and remains in the tree. This operation is performed in the evening, as the varnish flows only in the night. The next morning the workmen proceed again to the plantation; each shell is either wholly or partially filled with the varnish; this they scrape out carefully with their knives, depositing it in a vessel which they carry with them, and throw the shells into a basket at the foot of the tree. In the evening the shells are replaced, and the varnish again collected in the morning. This process is repeated throughout the summer, or until the varnish ceases to flow. It is computed that the fifty trees, which can be attended by a single workman, will yield a pound of varnish every night. When the gathering is over, the varnish is strained through a thin cloth loosely suspended over an earthen vessel.—*American Engineer.*

GINGILIE PLANT.

The Gingilie (*Sesamum indicum*) is said to be an African plant, and is supposed to have been introduced to the West Indies by the negroes. It is now pretty generally distributed, and in this country it thrives admirably in the Newera Kalawyia district.

The plant is cultivated for the seed, which yields a fixed oil. The method adopted in Ceylon of expressing the oil is rather primitive, and consequently it possesses an unpleasant flavour, and a brown, muddy colour. If properly prepared, the oil would form a very good substitute for sweet oil. The best method of preparing the oil is as follows: First, steep the seeds repeatedly in cold water. or boil them for a short time, till they are divested of the reddish-brown colouring matter contained in the epidermis of the seeds; then, when the seeds have become perfectly white, dry them in the sun, and express the oil in the ordinary way. The seed yields from 40 to 44 per cent. of a pale, straw-coloured oil. When thus prepared, the oil is perfectly devoid of smell, and may be used for extracting the perfume of the jasmine, tuberose, camomile, and yellow rose. To effect this, one weight of the flowers should be added to three weights of the oil in a bottle, which should be corked and left in the sun for forty days, when the oil will be impregnated with the perfume of the flowers. The gingilie oil is soluble in alcohol, saponifies with alkalies, solidifies by nitric acid, and combines with the oxide of lead. The gingilie oil is highly esteemed by Egyptian belles for its properties of cleansing the skin, and of imparting to it a bloom and lustre, and also of preserving the beauty and gloss of the hair. In Ceylon it is used for similar purposes. The negroes also use the seeds for making a sort of beverage something like coffee, by roasting the seeds and infusing them in water. The commercial value of the oil, in England, is 40*l.* per ton.—*Jaffna News.*

M'BOONDOO PLANT AT GABOON.

In a paper addressed to the French Academy of Science, MM. Rabuteau and Peyre have given a description of a plant which grows in the vicinity of the French settlement of Gaboon, and which the natives call *M'boondoo.* They had gathered it themselves in a moist soil, in the neighbourhood of the river Como, at 30 leagues from the frontier. It is very difficult to procure, because the sorcerers of the country conceal the plant with great care from the profane, so that its properties are still in a great measure a mystery. The roots vary in thickness between three centimetres and one (a centimetre is four-tenths of an inch); their length varies between 50 and 70. Their rind, whether fresh or dry, is reddish outside and a vivid red within; the root itself is mere hard wood. Both this and its bark are exceedingly bitter; their infusions, even when considerably diluted, still retain this taste to a high degree. They yield abundant precipitates even when treated either by iodide of potassium or phosphemolybdic acid; whence it may be concluded that they contain at least one, if not several, alkaloids. The effects produced upon animals may be briefly stated as follows:—When a very weak dose is injected under the skin of a frog, the poison only produces constraint in the limbs, a sort of paralysis, which prevents the creature from leaping easily, and makes it craw like a toad. But notwithstanding this substance does not act like woorali, since the power of muscular contraction is not impaired when the operator excites the nerves. With a dose of three milligr., the extract, introduced under the skin, after causing the constraint alluded to, brings on tetanic convulsions when the animal is touched, or the table on which it lies is struck with the hand or otherwise. Nevertheless, the creature does not become rigid as when poisoned with strychnine; and if it has received a weak dose, it will recover in the course of a few hours when put into water. Hence it might be concluded that the poison is rapidly eliminated from the animal economy.—*Galignani.*

GREASE TREE.

In China there grows a tree known as the Grease Tree. It is said that large forests of this vegetable lubricant are to be found there, and they form a source of a considerable local traffic. This tree not very long ago was imported into India, and it is said that the experiment of cultivating it there has proved quite successful. In the Punjaub, and North-western provinces generally, it grows as rapidly and as vigorously as in its native soil.

CHINESE GRAFTING.

A very peculiar method of grafting is practised in China. In spring the young shoots of the chrysanthemum are inserted into the stalk of the *ai* plant (wormwood?), by making an incision, cross shaped, in the stem of the latter, and binding the two tightly together with a piece of bast or hemp. After the incision has been properly bandaged, a flower-pot is put over it, bottom downwards, the plant passing through the hole in the pot, which does not rest on the ground, but upon four bricks placed under it, about six inches high. Earth is then put into the pot, and the plants gradually unite, taking root at the same time in the pot. As soon as the chrysanthemum flowers, the stem of the *ai* is severed immediately under the pot, and the whole is removed from the nursery to the garden or verandah. The grafting "strengthens" the chrysanthemum, which would otherwise produce but a very poor flower. The method is most ingenious, and the plants seem to unite very readily.—*Notes and Queries on China and Japan.*

POMOLOGY.

M. André Leroy, of Antwerp, is engaged on a Dictionary of Pomology; three large volumes are ready, and treat of pears, apples, quinces, service trees and medlars. Two more volumes will complete the work, one of which will treat of stone-fruits, the other of grapes and miscellaneous fruits. Each species of fruit is treated in an elaborate way, and to the mode of its culture is prefixed a history of its culture (besides several types of each variety, 915 varieties of pears are described), and each description is accompanied by a woodcut.

SILK AND SUNFLOWERS IN MAURITIUS.

WE gather from the last Annual Report of the Royal Society of Arts and Sciences of Mauritius, that they had received a communication from the "Silk Supply Association," asking whether Silk could be grown in the island, and laying down as a principle, that wherever the mulberry-tree will grow, there silk can be produced. The Society referred the question to a committee, who report unanimously that, "not only can the mulberry be cultivated and the silkworm reared in Mauritius, but that an establishment founded on certain principles (which they indicate) would implant the industry of the silk-grower on a firm basis in the island." The committee feel so confident of success, that they offer to take the management of the establishment; and we notice that a specimen of silk grown in Mauritius, and reeled more than twenty years ago, was valued at 30*s.* a pound in the London market last January.

Another plant, the Sunflower (*Helianthus annuus*) is to be cultivated, and seeds have been distributed among persons willing to undertake the task. It is popularly believed that plantations of sunflowers tend to improve local climates, by neutralising the effect of marsh air, and checking the liability to intermittent fever; and in some parts of Holland and the South of France the growth of sunflowers has been encouraged as a means of sanification. The same motive has led to the experiment now making in Mauritius, where some of the planters remark that, apart from all other considerations, the seeds of the sunflower yield a valuable oil, and are much relished by poultry.

A climbing plant known to botanists as the *Telfairia* (or *Joliffia*) *Africana*, was formerly abundant in Mauritius, but has, for some as yet unexplained reason, completely disappeared from the island. The plant being useful as well as ornamental, growing to a great height and bearing seeds which yield a rich sweet oil, is to be reintroduced; and at the request of the Governor, Sir Henry Barkly, a supply of seeds has been forwarded from Zanzibar by Dr. Kirk.—*Athenæum.*

BRITISH AND FRENCH BEETROOT SUGAR.

MR. JAMES CAIRD, with a communication to the *Times*, dated November 14, 1870, has sent a sample of the Sugar made by Mr. Duncan this season at Lavenham, in Suffolk, from Beet grown by the farmers in that neighbourhood. It brought the highest price in the market for sugar in crystals. Mr. Duncan was then converting into sugar about 400 tons of roots a week.

This was the third year of the Lavenham factory, and of the growth and manufacture of English beetroot sugar on a considerable scale—a scale equal in extent to that of Continental sugar factories. The analysis of the roots in both previous years had shown the quality to be satisfactory, but chemical and mechanical means for fully extracting it proved defective. There have been many other difficulties inseparable from a new undertaking, inexperienced hands not being the least, but perseverance and the exercise of great intelligence have triumphed, and the successful introduction of a new and most profitable agricultural industry into England has been accomplished. Mr. Duncan has now satisfied himself that the growth and manufacture of beet sugar can be carried on in Suffolk with quite as much success as in the north of France.

The total value of the syrup produced in one week is 960*l.* The expenditure, including cost of roots, Government duty, and working expenses, does not exceed 660*l.* So there is a handsome balance for interest of capital and profit, besides the value of the refuse pulp sold, and thus returned to the land for cattle food. The roots are, no doubt, richer in sugar this year than usual; but, on the other hand, sugar is very cheap.

Broadly stated, the conversion of the roots into sugar has more than doubled their value, though bought from the farmer at a price more remunerative to him than any other article he produces. The land is not impoverished, as nearly the whole of the feeding properties of the beet are returned to it to fatten cattle. The whole available surplus labour of an agricultural parish receives indoor employment in the sugar factory, during three or four months of the slackest time of the year, and at good wages. Capital is profitably employed, and trade of all kinds in the neighbourhood benefited, while the general supply of sugar is augmented.

This opens a large question. If, in the southern and eastern counties, we can grow beet sugar as profitably as in the north of France, we can compete—as France has successfully competed—with cane sugar from any quarter. To what extent would it be prudent, with our present limited experience, to anticipate the successful application of this new industry in England?

Mr. Campbell, of Buscot Park, in Berkshire, is conducting on a great scale a similar experiment, so far as the growth of the sugar-beet is concerned, but with the ultimate intention of being able to convert the root either into sugar or spirit, as may at the time be most profitable. The weight and quality of the sugar-beet grown on his estate this season cannot be surpassed. Thus, in Berkshire as in Suffolk, the soil and climate have proved equally suitable. There is no appreciable difference in the climate of the counties adjoining these, and we may therefore reasonably assume that, on all soils on which mangold is now advantageously grown in the counties from the Wash to the English Channel, sugar-beet may be gradually introduced. Now it so happens that two-thirds of the entire acreage of mangold in the United Kingdom are grown in these southern and eastern counties. There is as yet no means of judging how much further the limit may be extended. It is very likely that the south-eastern counties of Ireland may be found suitable.

And here a very important consideration should not be overlooked. The farmer will run very little risk by trying the experiment as a grower of beet, for Dr. Voelcker has clearly shown by analysis that one ton of English sugar-beet is equivalent in nutritive qualities, as cattle food, to 1½ ton of common mangold. Therefore, if the farmer cannot deal with the sugar factor, he can use the beet with the same advantage for cattle food, as, though the crop is less bulky, his 20-ton crop of beet will be as nutritive as the 30-ton crop of mangold.

About 200,000 acres of mangold are grown annually within the area above indicated. One-fourth of this, if applied to sugar-beet, should yield 60,000 tons of sugar, or about one-tenth of the present consumption of the kingdom. This would seem a not very remote result of more extensive trials, and when attained the further progress would be rapid. But, as a warning, it did not pay Mr. Duncan either the first or the second year, and he is no ordinary man. He combines in a remarkable manner business capacity with chymical and engineering knowledge. These, with further experience carefully sought on the Continent, and that within his own factory at Lavenham, have led him to an entirely successful issue in the third year. But the business is quite new in this country, and men are not yet educated to it. Enough, however, has been done to show that success may be anticipated by those who can bring to it a like command of capital, skill, and perseverance.

In the *Chamber of Agriculture Journal* it is remarked:—A favourable season has proved what might have been known before and long ago from experience, that both the climate and a great portion of the soil of England are quite as well adapted to the cultivation of the sugar, or Silesian beet, as well as all other kinds of roots, as any part of the European continent; and that with careful cultivation the percentage of sugar will be quite as great as in either France or Belgium. Professor Church, of the Royal Agricultural College at Cirencester, has taken up the subject in a spirited manner, and is throwing light upon it in a course of lectures delivered before the Cirencester Chamber of Agriculture. His lecture at the October meeting of the Chamber bore upon the feeding properties of the pulp of beetroot rather than on the cultivation of the plant; and he showed by the results of analysis that one ton of the pulp is equal in feeding power to a ton and a half of the gross roots and to two tons of the common mangold wurzel. This is on account of the large proportion of albumenoids contained in the sugar-beet, as well as other nutritive substances. This statement corresponds with the experiments of Dr. Voelcker, as recorded in the *Journal of the Royal Agricultural Society of England*. Professor Church also ascertained by analysis that the beetroot grown upon the College Farm contained from 12 per cent. to 13·5 per cent. of sugar, which is quite equal to what is produced in any part of the Continent, and superior to most, where, however, the manufacture is carried on successfully.

Mr. George Ellis has sent to the *Times* an analysis made by Dr. Voelcker of several samples of sugar-beet grown this year in the county Kilkenny; this being the second year Mr. Ellis has had the experiment tried in that locality. The best result last year was 10·91 per cent. of crystallisable sugar, the best this year 14·81. When it is taken into account that 6 per cent. for spirit and 8 per cent. for sugar will pay the manufacturer, we may fairly say that our two years' experiment has proved the power of growing sugar-beet in Kilkenny fit for a manufacturer to deal with. Mr. Ellis concludes with a passage from Dr. Voelcker's letter, which accompanied the analysis:—"I question much whether better and richer sugar-beets have been grown this season in the most favoured beetroot districts of Belgium or France."

The annual value of the raw sugar made from beetroot in France now exceeds five millions sterling. The total number of beetroot sugar factories on the Continent now amounts to more than 1,800, turning out the enormous quantity of 611,000 tons of sugar per season. In the year ending 1867 no less than 55,000 tons of beetroot sugar were imported into the United Kingdom; or, in other words, we paid continental makers 1,600,000*l.* for a commodity which, it is believed, we could just as well have produced ourselves. Beetroot sugar is successfully competing with cane sugar in the London and other English markets; and probably a remission of the Customs and Excise duties would have no other effect than to increase the consumption of beetroot sugar, and render its manufacture more profitable than it already is.

TREES OF CALIFORNIA.

PROFESSOR BREWERS read to the American National Academy of Science at the recent meeting a paper on the distribution of the forest vegetation west of the Rocky Mountains. He showed that forests in California are fewer than in the east. They are altogether north of San Luis Obispo, and lie on the west flanks of the coast ranges and the Sierra Nevadas. Pine, spruce, fir, and cedar constitute the bulk of the forests. There are 50 species of conifers in California, all peculiar to the country. A long account was given of the big trees, the largest of which was said to be 91ft. in circumference, 260ft. high, and probably 1,400 years old. The statements of the age of these trees have in some instances been grossly exaggerated.—(*See Notable Things of our own Time.*)

Geology and Mineralogy.

GEOLOGICAL SYSTEMS AND ENDEMIC DISEASES.

A PAPER on this subject has been read to the British Association by Dr. Moffat. The writer shows that the soil has an influence on the composition of the cereal plants grown upon it, and on the diseases to which the inhabitants are subject. The district in which he practises consists geologically of the carboniferous and new red sandstone or Cheshire sandstone systems. The inhabitants of the first are engaged in mining and agricultural occupations, those of the latter in agriculture. Anæmia, with goître, is a very prevalent disease among those living on the carboniferous system; whilst it is almost unknown amongst those living on the new red sandstone system; and consumption is also more prevalent amongst the inhabitants of the former. As anæmia is a condition in which there is a deficiency of the oxide of iron which the blood naturally contains, Dr. Moffat was led to make an examination of the relative composition of the wheat grown on the soil of Cheshire sandstone, carboniferous limestone, millstone grit, and a transition soil between Cheshire sandstone and the grit. The result of the analysis shows that the wheat grown on the soil of the Cheshire sandstone contains the largest quantity of ash, and that there is a larger quantity of phosphoric acid in it than in the soils of the carboniferous and millstone grit systems; also a much larger quantity of oxide of iron than in either of them. He has calculated that each inhabitant on the Cheshire sandstone, if he consumes a pound of wheat daily, takes in nearly five grains per day of the sesqui-oxide of iron more than the inhabitant of the carboniferous system, and who seems, therefore, to be subject to this great liability to anæmia in consequence of the deficiency of iron and phosphoric acid in the food he consumes. It is not only in the wheat grown upon the carboniferous system that there is a deficiency in the quantity of oxide of iron, and the phosphates, says Dr. Moffat, but also in the blood of the animals reared upon it; so that the inhabitants upon that system take in a minimum quantity of these constituents of the blood, compared with that taken in by the inhabitants of the Cheshire sandstone. He stated that sheep were liable to anæmia—a fact which he attributed to sheep-walks being upon trap and limestone hills, in the soil of which there is but little, if any, iron.

Dr. Turnbull, of Liverpool, said the facts contained in Dr. Moffat's paper were of practical interest both to the agriculturist and the physician. There was one fact which was especially interesting to him (Dr. Turnbull). Dr. Moffat had told them that there was less phthisis or consumption on the red sandstone than on the carboniferous soils. It was well known that there was a great variation in the mortality from this most common of all diseases, and he (Dr. Turnbull) had contended, in a work which he had published, that the causes should be investigated, in order to limit and prevent consumption. He drew attention to this in 1859, and then showed that a remarkable diminution in the mortality from phthisis had taken place in Liverpool by the sanitary improvements there. Since then Mr. Simon had caused an investigation to be made into the general effects of sanitary measures on the health of twenty-five large towns. By this investigation it was found that a similar improvement to that of Liverpool had taken place in many of these towns; that in Salisbury the mortality from this disease had been reduced by one-half, and that this reduction was due to the drying of the soil. This led to an investigation of the effects of geological conditions of soil in three south-eastern counties. Dr. Buchanan established the fact that dampness of soil is a powerful cause of consumption. Dr. Buchanan's was the first contribution to the knowledge of the effect of geological conditions on health; Dr. Moffat's was the second contribution, and it showed that geological influences on health may be indirectly as well as directly induced.

PRIMITIVE VEGETATION OF THE EARTH—THE OLDEST TREE IN THE WORLD.

Dr. T. W. Dawson, F.R.S., in a lecture delivered at the Royal Institution, has exhibited, by means of the electric light, a fragment of a large tree, of the genus Protoxita, being a portion of a trunk of, probably, the Oldest Known Tree in the World, preserved by the infiltration of its tissues with silica. A tree of still higher organisation, belonging to the true exogens, is known in the middle Devonian (Syringoxylon mirabile); but as no such wood has been as yet found in the carboniferous strata, some geologists withhold their belief in this tree till other specimens are discovered. Twenty years ago, scarcely anything was known as land-plants older than the great coal formation. In 1860 Goeppert knew of only one plant in the lower Devonian and of fifty-seven in the upper Devonian; but since then the researches of Dr. Dawson have raised the Devonian flora of Eastern America to 121 species, which, added to those of Europe, gave a total of about 180 species. The flora of the upper Silurian at present is in a similar condition to that of the Devonian ten years ago, and the lower Silurian has not as yet afforded any land-plants; but the search is not hopeless. In his concluding remarks Dr. Dawson expressed his belief that the immense deposits of graphite in the Laurentian strata of Canada represent carbon of vegetable origin, probably in part produced by land-plants as yet unknown to us in any other way. As the palæozoic was the age of tree-like ferns and club-mosses, so the Laurentian may have been the age of forests of mosses and lichens towering to the height of trees—a period when vegetable life existed in its completest and grandest forms, in advance of the time when it was to be brought into subordination to the higher life of the animal. . . . . . We have much yet to learn of this period; but there remains a most wonderful and suggestive correlation—namely, that our minds are able to trace in these perished organisms structures similar to those of modern plants, and thus to reproduce in imagination the forms and habits of growth of living things which have so long preceded us on the earth.

NEW SOUTH AFRICAN DIAMOND-FIELDS.

THE REV. DR. WILLIAMS, Dean of Graham's Town, in a letter to the *Times*, describes the discovery of vast and rich Diamond-fields, near the province of Cape Colony. "This large tract of country, close to our immediate borders on the eastern frontier," writes the Dean, August 13, "now found to be richly diamondiferous—washed by the Vaal and the Orange rivers, and without any reliably assignable limits as yet; for diamond parties have found gems glittering on the very surface, within three days' hard riding of one another, not to mention the large supplies found in clay and gravel deposits turned up by the pick, a foot or two below ground, after a few days of unskilled search—is, in every sense of the word, a diamond-field or diamond country—not a diamond mine. The mine as yet, if there be any, is not in the least degree traceable. All that is certain is that there the precious gems are—on the surface and close to the surface, spread over an area of hundreds of square miles that were uninhabited and unnoticed until within two months previously; little frequented, even by wild game, as there is neither bush nor grass on the surface, and which (had there been any one claiming rights of ownership over it) might have been all purchased by any buyer, to the great joy of the seller, for a few shillings per thousand acres. There, nevertheless, the precious gems are, unearthed now and found every day by the simple process of washing and sieving the rubbish, and thither a population with picks and shovels and rakes is rapidly following from every—even the most distant—town of the Colony. It is about 400 miles from here, about twice that distance from Cape Town. They are travelling for it either on foot or on horseback, or by horse-cart or mule-cart or ox-waggon. Partnership companies of from four persons to sixteen persons are leaving this little city every second or third day. The higher classes of gentry and the lower classes of working people are going together without distinction. The pick, crowbar, shovel, sieve, and washing-cradle are the common accompaniments of all."

The well-known Professor Tennant has delivered to the Society of Arts a most interesting lecture on "South African Diamonds." Mr. Tennant commenced with the history of the discovery of diamonds at the Cape of Good Hope. In March, 1867, Dr. Atherstone, of Graham's Town, received by post in an unsealed, unregistered letter, a rough diamond which had been picked up on a farm in the Hope Town District, and forwarded by Mr. J. O'Reilly to Mr. Lorenzo Boyes, Clerk of the Peace for the district of Colesberg, who sent it to Dr. Atherstone in order that he might give his opinion as to the probability of its being of any value. He had not seen a rough diamond before, but, after taking the specific gravity, testing the hardness, and examining it by polarized light, he decided that it was a genuine diamond of considerable value; and, perceiving the great importance of such a discovery to the Colony, he at once wrote to the Colonial Secretary suggesting, that it should be sent to the Paris Exhibition, and afterwards sold for the benefit of the finder. This fortunate person was a Dutch farmer, named Schalk van Niekerk, who, seeing the children of a neighbouring boer playing with some bright stones, was struck by the appearance of one, which he offered to buy of the mother. She laughed at the idea of selling the gem, and gave it to him at once. He showed it to Mr. O'Reilly, who was returning from a distant hunting expedition, and so it reached Dr. Atherstone.

At the close of the Paris Exhibition the stone was purchased by Sir Philip Wodehouse, then governor of the colony, for 500*l*.

Comparing the South African with other diamond-fields, Professor Tennant remarked that it had hitherto been unusual to receive more than one large diamond—say of 40 carats—in the course of a single year, but the new fields had yielded no less than five stones exceeding this weight within that time. He had models of many. There was one of 56 carats, and another weighing 83 carats, which arrived last year, and proved to be an exceedingly beautiful stone. It was now in the possession of Messrs. Hunt and Roskell. He anticipated that we should have diamonds from this region exceeding the Koh-i-noor in size, and equalling it in beauty when cut and polished. The lecturer then proceeded, by means of diagrams, to explain the technical terms used in describing the forms in which the crystals of diamonds were found, and then described some peculiarities of the stone by which it might be readily distinguished from other crystalline minerals of somewhat similar appearance. One means was by chipping a piece off the stone, and observing the form of the fragment; but it was not absolutely necessary to apply the test of cleavage, for, as it was very rare indeed to find a diamond perfect and without a flaw, by examining the surfaces of a flaw the character of the stone might be determined. The diamond, although the hardest of substances, was one of the most brittle, and it was probably owing to ignorance of this fact, and carelessness on the part of the diamond seekers, that so many of the diamonds brought from the Cape were broken. The principal diamond-bearing districts at present discovered were the valleys of the Vaal, Orange, and Reit Rivers. A great variety of other minerals had been found in the same neighbourhood. The pebbles consisted of rock crystal of different colours, and, together with agate, jaspers (black, red, and ribboned), quartzite, garnet, spinel, peridot, blue corundum, were abundant, while iron-ore, sandstone, basalt, and granite were also found in these regions. In the course of the discussion which followed, Mr. Rabone, who stated that he had resided for 18 years in the neighbourhood of the diamond-fields, expressed his regret that this valuable region had been separated from the dominions of the Crown. Mr. Rawlinson drew attention to the great importance of diamonds to the artizan, the mechanic, and the engineer. They were now employed for many purposes instead of steel, for drilling rocks, for facing millstones, and for piercing iron and steel. Mr. Fondred said that the discoverers of diamonds at the Cape, he had been informed, frequently made the mistake of placing a value so exorbitantly high on the stones they sent over here to be sold, that the agents were unable to dispose of them. Mr. Le Neve Foster said they made no allowance for the loss of weight in cutting. Professor Tennant said that only about 10 per cent. of those found were of the first water. Many of those received from South Africa were very defective. In the large one of which he had spoken weighing 83 carats there were three flaws; nevertheless, 5,000*l.* was offered to the finder while it was still in the "rough." The chairman then moved a vote of thanks to the lecturer, which was carried with acclamation.—*Times.*

The following is an extract from a letter addressed by the Austrian consul at Port Elizabeth to Professor Hochstetter, of Vienna:—"The diamonds which have been discovered here are of extraordinary size and beauty; the territory in which they are found is upwards of 1,000 miles in extent. Every post brings news of the discovery of diamonds in various places, but they are most abundant at Likatlong, near the frontier of the Orange River Free State. Hitherto they have been found only on the surface. They vary in weight from half a carat to 150 carats. One found on my property was of the first water, in shape like an octahedron, and weighed 30½ carats; another, of 46 carats, was sold in London for 4,600*l.* The stone weighing 150 carats was broken, and a piece of 23½ carats is now in my possession. Hert Manch, who has gone up the Vaal River, is said to have discovered a diamond mine, which also contains granates, topazes, and other precious stones."

DIAMONDS IN AUSTRALIA.

THE work of mining for Diamonds is going on quietly but steadily in the Mudgee district. It is stated that the Australian Diamond Mines Company have forwarded to England 984 stones in all. Other parties besides the two Melbourne Companies are said to have washed 12 loads, and obtained 110 diamonds, weighing 3½ dwt., equal to 26 carats; nine of them weighed 1 carat each. They state their earnings to have been 12*l.* a week.

A list of 36 persons certified to having found diamonds, in all about 2,000, of which some 600 were sold in New South Wales, and 1,200 forwarded to Melbourne. Besides this, there were many diamonds in the hands of Chinese and others, of which no accurate account could be obtained.

In the colony of Victoria another discovery has been made. Some small stones found in Kidd's Gully, Daylesford, were brought to Melbourne for examination, and one of them was pronounced by Mr. E. Brunke, jeweller, to be a diamond of the first water, and nearly a carat in weight. It was found in Messrs. Cugley, Thorp, and Co.'s claim. Mr. Cugley asserts that stones of the same description have passed through his hands in considerable numbers when washing up tailings at various times, Mr. Brunke says he has brought home some 20 diamonds within 6 months, found by various diggers within a radius of 10 miles from Talbot.

The mail steamer took with it 378 diamonds, weighing 87 carats, on account of the Australian Diamond Mining Company. The parcel is the produce of four weeks' work, and it is by far the best yield that the company has yet obtained.

How shall the gems be detected by one who has had no experience, and who in a jeweller's shop could not separate them from quartz or French paste? The difficulty can only be overcome by testing such stones as may be suspected to be precious. Let these be preserved until the day's washing is over, and then tried by the very sure operation of attempting to cut with their sharp corners glass, crystal, or quartz. When they are too minute to be held between the finger and the thumb, the specimens may be pressed into the end of a stick of hard wood, and run along the surface of a piece of window glass. A diamond will, in such case, make its mark, and cause, too, a ready fracture of the glass in the line over which it has travelled. Tested in a similar way upon a crystal of quartz, the diamond will make such an impression as no one crystal can have upon another. But a yet more certain and peculiar characteristic of the diamond lies in the form of its crystals. The sapphire and the zircon will readily cut glass and scratch quartz, but they have not the curved edges of the diamond. In small crystals this peculiarity can only be observed by using a magnifying glass, but it is invariably present in the true gem, whether it be large or small. It is, perhaps, rare to find a diamond with four curvilinear faces, but such a circumstance places its identity beyond the domain of doubt. Another form of the diamond is that of the octahedron, or eight-sided solid, with the edges replaced by interrupted narrow convex surfaces. Such interrupted, convex, or rounded angles are sure indications of genuineness.—*Mechanics' Magazine.*

THE CREATION OF GOLD.

THERE are but few metals, or metallic minerals, to be found in quartz lodes, and they are gold, iron, and arsenical pyrites—

throwing some quartz stones from the street at an old boiler by the roadside, when one of the boys picked up a mass of golden quartz containing 10½ oz. of pure gold." A fossicker at Little Bendigo, while in the act of carrying some 7 dwt. of gold to Ballarat for sale, picked up a 6 oz. nugget in Mopoke Gully. A Sandhurst paper reports the discovery in the Golden Pyke Company's ground of a reef, not very thick, but which may almost be said to be more gold than quartz; very heavy pieces of solid gold, over 7 oz. in weight, have been taken out of it. Berlin, the field of nuggets, maintains its reputation. A party of Chinese got 50 oz. in two pieces.

Another instance of the remarkable way in which nuggets are sometimes turned up in this colony was furnished, when a nugget weighing 69 oz. was ploughed up on Mr. Allen's farm, Mount Prospect, Bullarook, near Ballarat. As nuggets are always welcome things, and as this may lead to the opening up of new ground, it may be honoured as a very pleasant and "welcome stranger." The lump was only a few inches below the surface, and has what looks like ferruginous conglomerate attached to it, but is nearly all gold, and well waterworn.—*Melbourne Argus.*

The South Devonshire Company has astonished the public, perhaps, the most of all, with its splendid yield of 16 oz. to the ton, or 670 oz. from 42 loads for a few days' crushing. One very great and important fact as regards quartz mining is thought to be now thoroughly established—namely, that quartz reefs do not, as previously contended for by many scientific judges, invariably become poorer the deeper they go down from the surface, and eventually become non-auriferous. A recent number of the *Inglewood Advertiser* says "that another splendid lot of nuggets has been found at Berlin. The weights were as follows: 117 oz., 161 oz. 10 dwt., 102 oz. 7 dwt. 12 gr., 80 oz., and 5 oz These were got by Lorimer and party within the paddock, and at a depth of 8 in."

THE ANDAMAN ISLANDS.

It appears that we are in a fair way to lose about 3,000 square miles of British territory. The *Indian Daily News* calls attention to a report recently issued on the vegetation of the Andaman Islands, in which Mr. Kurz, the curator of the Herbarium of the Calcutta Botanical Gardens, gives it as his opinion that these islands are in a sinking state, and must eventually disappear. Mr. Kurz has arrived at this conclusion from having observed, at various points of the islands, a vast extent of decaying vegetation, stumps of trees, &c., covered by or open to the action of the sea. There are upwards of 6,000 convicts on these islands; but there is no occasion for immediate anxiety on their behalf, for, according to Mr. Kurz, the submersion is proceeding only at the rate of one foot in 100 years, and it will take 1,000 years before all the stores and houses along the beach at Ross Island disappear under water.—*Pall Mall Gazette.*

AGE OF THE WEALDEN.

Mr. J. W. Judd has read to the British Association a paper on this inquiry: The Wealden constitutes one great continuous formation, with well-defined palæontological characters, and its beds can only be referred to the different members of the established geological classification by violent and arbitrary divisions. It must, therefore, stand as one of the terms of that new system of terrestrial classification which Prof. Huxley has shown must be formed. The passage of the Upper Oolites into the Wealden, and that of the Wealden into the Upper Neocomian, are each of them gradual. Freshwater deposits were formed continuously, but not contemporaneously, over the whole Wealden area. The period of the English Wealden commenced towards the close of the Oolitic period, and ceased towards the beginning of the Upper Neocomian. In the midst of the Wealden, at Punfield Cove, near Swanage, we have a representative of the upper part of the Middle Neocomian. The Fauna of this marine band at Punfield has striking affinities with that of the coal-bearing strata of Eastern Spain, which are there more than 1,600 feet thick. The North-German Wealden is quite unconnected with that of England, and is probably the product of another great river, and not strictly contemporaneous with the latter; for, while it appears to have commenced about the same period, its duration was considerably less, it having terminated before the close of the Lower Neocomian.

Sir Charles Lyell looked upon these investigations as of the highest theoretical importance, because they related to the enormous gaps upon which Mr. Darwin dwelt, in respect to the great imperfections of the geological record. The observations which had been made by Mr. Judd showed when these long series of freshwater strata were deposited, and also assisted in confirming the conclusion that whenever we found great gaps in a marine series there must have been a vast lapse of time to have allowed those changes to take place. Prof. Huxley also took part in the discussion.

THE MOUNTAIN LIMESTONE.

The late Prof. Edward Forbes had observed in his dredging expeditions that those Testaceæ whose shells are coloured, or marked with distinct patterns, rarely inhabit greater depths than fifty fathoms. As he found certain mollusca in the carboniferous limestone which retained the marks of their colour patterns, he drew the conclusion that the Mountain Limestone was formed in shallow seas of not greater depth than fifty fathoms. Since Prof. Forbes's death, however, shells with distinct colours have been brought up in considerable numbers from one hundred fathoms water. Besides this, it seems that shells with tint-marks are so comparatively infrequent in these rocks that generalisation from them is unsafe. Their animals may have throwing some quartz stones from the street at an old boiler by the roadside, when one of the boys picked up a mass of golden quartz containing 10½ oz. of pure gold." A fossicker at Little Bendigo, while in the act of carrying some 7 dwt. of gold to Ballarat for sale, picked up a 6 oz. nugget in Mopoke Gully. A Sandhurst paper reports the discovery in the Golden Pyke Company's ground of a reef, not very thick, but which may almost be said to be more gold than quartz; very heavy pieces of solid gold, over 7 oz. in weight, have been taken out of it. Berlin, the field of nuggets, maintains its reputation. A party of Chinese got 50 oz. in two pieces.

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ON THE MOUNTAIN LIMESTONE OF FLINTSHIRE AND PART OF DENBIGHSHIRE. BY MR. G. H. MORTON.

AN examination of the list of fossils, without attention to the numerical importance of the species, conveys the impression that both the upper and middle sub-divisions of the limestone have each many peculiar fossils, and an undue distinctive character might be supposed to separate them. A more critical examination, however, of the relative abundance of the species leads to the conclusion that the common forms have a considerable range, and that the apparent difference arises through the occurrence of rare species. In Flintshire, within fifteen miles from Liverpool, there is a prominent ridge of carboniferous or mountain limestone, extending from Prestatyn to Llandegla, a distance of twenty-one miles; the strike N. by S.E. and S. Instead of a general description, four favourable localities were selected as centres of observation—Mold, Holywell, Newmarket (Flintshire), and Llangollen. Neither Mold nor Holywell are actually upon the limestone; Llangollen was included on account of the grand section of the Eglwyseg rocks. The Eglwyseg rocks present an estimated thickness of 1,200 feet. The millstone grit succeeds the limestone, about 800 feet thick, coal being worked above it at Tyfynuchaf. To the west of Mold is a fine section. The vertical section of the strata at Newmarket was compiled from three horizontal sections, each showing the thickness of a sub-division. The lower grey and black limestones resting on Silurian strata are 750 feet thick at Moel Hiraddug. The white limestone ridge, 350 feet thick, is very different from any of the Hiraddug strata, as it also is from the black and grey limestones and shales, 300 feet thick, which crop out from under the overlying shales and sandstones of the millstone grit. Consequently, the white limestone of Axton occupies an intermediate position, which was confirmed by the fossils it contained. Appended to Mr. Morton's paper was a list of ninety-four fossils found in the district which he had described.—*Proceedings of the British Association.*

THE COAL-FIELDS OF ENGLAND.

THE following is an abstract of a paper read by Professor Hull to the British Association, the subject of his remarks being the Extension of the Coalfields beneath the newer Formations in

England. The paper was accompanied by maps and a diagramatic section from the north-west to the south-east of England, intended to represent the arrangement of the strata along this line of country.

Professor Hull commenced by referring to the paper which Sir R. I. Murchison had laid before the Association at Nottingham, entitled, "On the parts of England and Wales in which Coal may, or may not, be looked for," and expressed his gratification that his own views, arrived at by a somewhat different process of reasoning, coincided in the main with those of his respected chief; especially as regarded the absence of coal in the Eastern and portions of the Midland Counties now overspread by the Mesozoic formations. He then proceeded to show that there was evidence for believing that the coal measures were originally deposited in two continuous sheets, one to the north, and the other to the south, of a ridge of old land formed of Silurian rocks, which stretched eastward from Shropshire, along the south of the Dudley coal-field. This ridge, or barrier, had probably never been altogether submerged beneath the waters in which the coal measures were deposited. Towards the north the boundaries of the coal formation were formed by the Cambro-Silurian rocks of North Wales, the Lake District, and portions of the Southern Uplands of Scotland. The southern limits were formed by the barrier of old land already described: and over this intervening area the coal-measures were spread in one continuous sheet, and attained their greatest vertical dimensions towards the north-west. To the south of the barrier the strata were deposited in greatest thickness towards the west or south-west. At the close of the coal period disturbances of the strata, resulting probably from lateral pressure acting from the north and south, took place over the whole carboniferous area of the North of England, whereby the strata were thrown into a series of folds, the axes of which ranged along approximately east and west lines. These disturbances were accompanied and followed by enormous denudations, by which the coal measures were swept away over large tracts of the North of England, and the northern limits of the Lancashire and Yorkshire coalfields were approximately determined. Referring to the tract south of the central barrier, it was shown that the east and west flexures, being parallel to those of the North of England, were referable to the same geological period—the Post-Carboniferous (or Pre-Permian). At this period the northern and southern limits of the South Wales coalfield, the axis of the Mendip Hills, and the easterly trend of the culm measures of Devonshire were approximately marked out. Denudation of strata on an enormous scale accompanied these movements. After the deposition of the Permian beds over the inclined and denuded edges of the carboniferous rocks, disturbances, accompanied by extensive denudation, took place along lines nearly at right angles to those of the preceding period—along the north and south lines (approximately). To this epoch the axis of the Pennine chain and all north and south trendings of the strata were to be referred. Some of the results brought about by these movements were the disseverance of the Lancashire and Cheshire from the Yorkshire and Derbyshire coalfields, the determination of the western limits of the Flintshire and Denbighshire coalfields, the disseverance of the Forest of Dean coalfield from that of South Wales, and the uptilting of the lower carboniferous rocks along the eastern margin of the Somersetshire coalfield beneath the Jurasic formations. From these considerations it seemed clear that the basin-shaped form of nearly all the coalfields (the basins being sometimes partially concealed by Mesozoic rocks) was due to denudation acting over areas of elevation intersecting each other nearly at right angles, and corresponding to two distinct epochs—the Pre-Permian and Pre-Triassic. The author then proceeded to show that over these carboniferous basins the Permian and Triassic rocks were distributed according to a well-defined plan of "south-easterly attenuation," thinning away towards the south-east; and concluded by discussing the views of Sir R. I. Murchison, Professor Ramsay, and Mr. Godwin-Austin, regarding the existence or absence of coal under the cretaceous or tertiary strata of the South of England.

The President of the section said the paper was of the highest geological importance at the present time, when we had so much excitement with regard to the probable extent of our coalfields, and at a time when the question was engaging the attention of a Royal Commission.

Professor Phillips confessed to very great interest in investigations which referred to the extent of our actual possessions and future prospects in regard to coal supplies; but he entertained the doubt whether, after all, their prospects of obtaining coal from the extent already known had not been taken at the minimum.

Mr. Warington W. Smyth thought it highly important that the paper should go forth to the world as pointing out that there was very great reason for believing that we could not indulge in wild views of uninterrupted fields of coal to be wrought far to the eastward of our existing coalfields, and to the borders of the German Ocean. Whilst they ought to receive with admiration Professor Hull's paper as regarded what portion of the original enormous coalfields were left them, they might also consider its value very great, because it enabled them to see the great probability of certain lines beyond which they should not allow their imaginations to stray, or expect valuable coal-fields to extend.

A NATURAL GASOMETER.

During the excitement about petroleum in the United States, a well was bored in Ontario county, about twenty miles from

Rochester, State of New York, to explore for the valuable "ile." At a depth of 500 feet a cavity was pierced from which a rush of gas took place and has ever since continued. The boring is lined by a tube five inches in diameter, and up this the gas rises at the rate of from 15,000 to 18,000 feet every hour. When lighted, it produces, in a still atmosphere, a flame thirty feet long from the mouth of the tube; and the observations made on the stream of gas lead to the conclusion that it has not varied in quantity since it was first tapped. The temperature, so nearly as can be ascertained, is supposed to be about 50° Fahrenheit, and the illuminating power equal to that of six candles. The principal constituent is marsh gas 82·41, followed by carbonic acid 10·11, with smaller quantities of nitrogen, oxygen, and hydrocarbon. The source of this copious supply is supposed to be the formation known to American geologists as the "Marcellus shale," which in that region would be about 100 feet in thickness. If the supply—600,000,000 feet of gas in a year—is to go on, we shall probably hear of steps being taken to turn it to profitable use.—*Athenæum.*

GEOLOGY OF CORK HARBOUR.

THE superficial strata at the north and south of Cork Harbour are Devonian sandstone and schist. At Whitepoint, adjoining Queenstown, a grey limestone crops out from under this sandstone, and, continuing across the Channels, forms Haulbowline and Rocky Islands. On a piece of the above limestone in my possession is a cast of a portion of the vertebræ of (probably) a reptile. At one end it terminates at a decomposed part of the stone; at the other, it had been squared off for pairing before it came into my hands. Much, therefore, has been lost. The length of the remaining impression is 16¼ inches. There are also indications of the direction of a portion of the vertebræ having been twice changed before the final impression was made. At first the whole was in nearly a straight line; then a portion assumed a curve, which was increased by a subsequent movement. The earlier impressions are nearly obliterated.—*Athenæum.*

THE SCOTTISH GOLD-FIELDS.

DR. BRYCE has read to the British Association a paper "On the Matrix of the Gold in the Scottish Goldfields." Up to July 1869, the source of the gold of the alluvial workings of Sutherland had not been determined. Many of the miners had been at other diggings, where the gold occurred in quartz reefs, and, accordingly, their search was constantly directed to the discovery of such reefs, but without success. The author had directed his attention to the elucidation of this point, and had found that the banks of the Sinsgill burn consisted of alternating coarse whitish granite and a highly crystalline mica slate. On crushing the granite and washing the sand, grains of gold were found in every specimen. A similar result was obtained by crushing and washing specimens of the mica slate, but the gold was less abundant, and was absent from several specimens. Early in the last winter, gold grains were found in considerable quantity in the alluvia of the Errick and Nairn rivers towards their mouths, and were soon after detected at various points far up the channels of these streams. The author had examined the upper valleys of these streams, and found them to consist of granite and metamorphic slates, and in this granite gold was found in considerable quantities.

THE SOUTH WALES COAL-FIELD.

The following paper has been read to the British Association by Mr. William Adams, upon the "Geological Features of the South Wales Coalfield." The author estimated the area of the coalfield at 937 square miles, and the total quantity of coal originally contained in it at thirty-six thousand million of tons. Of this a large proportion remains yet to be worked. The coal towards the east is chiefly bituminous, in the centre of the field it becomes more free burning, while the western parts yield an anthracitic coal. The argillaceous ironstones are abundant and rich, interstratified with the coal measures, the aggregate thickness varying from 60 to 70 inches; but the production of native ironstone has decreased from 1,105,000 tons in 1855 to 628,845 tons in 1868, though large quantities of iron ore from other localities are imported. The production of coal is put down at 13,210,000 tons in 1868. The intersection of the coal-field by deep valleys places the lowest seam within 1,000 yards of the surface, so that the whole of the minerals can be won by pits of less than that depth over at least two-thirds of the coalfield. The measures dip north and south, so that they form a kind of basin, tolerably flat in the central parts. The beds are dislocated by a considerable number of faults, but no igneous rocks appear in connection with the carboniferous strata.

NEW SAFETY-LAMP.

For several years past various inventions have been patented, with a view to prevent the ordinary Safety-lamps (so necessary for working with in mines) from being tampered with. Locks of almost every conceivable description have been brought out, but in nearly all instances they have not been secure from the evil genius of the reckless collier, who, either to obtain a little more light, or to get at the flame for the purpose of lighting his pipe, will tamper with them. We have, however, just been favoured with a view of a lamp which appears to combine all the essentials so long desired, and by which any tampering with is shown in a very peculiar manner. The lamp is the invention of Mr. E. Booth, mining engineer, and managing partner of the

Silkstone Fall Colliery Company, near Barnsley, who is now having it patented. In the invention there is no lock whatever, or even fastener, the bottom being simply screwed and unscrewed by turning it at the bottom with the hand. After the wick of the lamp is lighted, the bottom is screwed on, and then it is ready for work. Should any endeavour be made to get at the flame, which could only be attempted by unscrewing the bottom, then the moment that the screw is turned round the light gradually goes out, and before the two parts can be separated the light is entirely extinguished. It is needless to say that on the men knowing that any endeavour on their part to tamper with the light would cause it to go out, and at once lead to detection, there would be few, or none, who would run the risk of doing so. The invention, we understand, is characterised by great simplicity, which, in itself, is a good recommendation.—*Mining Journal.*

GLACIAL PHENOMENA.

THE following papers have been read to the British Association: "On the Glacial Phenomena of Western Lancashire and Cheshire," by Mr. C. E. De Rance; "On the Pre-Glacial Deposits of Western Lancashire and Cheshire," by Mr. C. E. De Rance. The author believed that after the deposition of the Esker Drift the country rose to from 200 to 300 ft. higher than at present; but in the course of this elevation there was a pause, during which denudation took place, and the low plains, now covered with peat moss, came into existence. From the consideration of the present depths of the channel between Great Britain and Ireland, the author inferred that an elevation of 200 ft. would have caused the coast-line to run from the Mull of Galloway to St. David's Head; and Ireland would have been so connected with Wales as to render possible the migration of mammals, plants, and of man himself. Glaciers probably still persisted in the lake-district during the whole of this period of elevation. During a subsequent subsidence drainage became greatly obstructed, peat was formed, the sea encroached upon the land and worked its way eastward over the sea-bottom of Post-Glacial times—a movement yet in progress. Here and there sand has begun to blow, forming dunes.—"Observations on Modern Glacial Action in Canada," by the Rev. W. Bleasdell; communicated by Principal Dawson. The author described some phenomena of ice-transport observed in Canada, especially those produced by the flood, and anchor or pack-ice produced in the rapids of the Canadian rivers. To this he attributed the entire disappearance of Crab Island in the River St. Lawrence, near Cornwall. This island occupied about an acre and a half within the memory of men now living; it has now entirely disappeared, and the water above it is gradually deepening. The island, according to the author, has been carried away piecemeal by the action of miniature icebergs, floated off by a [illegible] the water produced by a dam of anchor-ice below.

Mr. G. H. Morton has read to the British Association a paper "On the Glaciated Condition of the Surface of Triassic Sandstone around Liverpool." The map of the Government Geological Survey was of great value to local geologists. The most important progress, however, in local geology had resulted from the superficial or drift deposits which cover the country, and the discovery of the glaciated condition of the sandstone beneath. These superficial accumulations had been divided into post-glacial deposits (consisting of drift-sand), bluish silt or mud, submarine forests; glacial deposits (including upper drift-sand, boulder clay, lower drift-sand). The latter subdivision was often absent; and, under these conditions, the boulder clay usually covers the surface. Mr. Morton explained that this clay is the dark red clay so extensively used in this neighbourhood for the purposes of brickmaking. It contains pebbles and boulders, varying in size from that of a pea to immense blocks 6 ft. in diameter, a large proportion of them being striated and ground flat on one or more surfaces by the action of the ice, similar to the specimens of boulders and pebbles brought from the glaciers of the Alps. In the course of his investigation he had been compelled to adopt a new theory, namely, that a great sheet of ice once travelled over this part of the country from the south-east to the north-west. The first striated surface discovered was between Parkhill Road and the Dingle, but had been destroyed by the erection of cottages over the place. This surface is 120 ft. above the sea.

SUBTERRANEAN CHANNEL.

Professor N. H. Winchell, in a recent Report on the Thunder Bay region, says:—"The north branch of Thunder Bay River disappears entirely in time of low water beneath a ledge of Hamilton limestone. But in time of high water, the mouth of the Subterranean Channel will not admit the raised volume of water, and after filling the basin of a little lake, which is nearly a mile in length, it passes overland through the channel represented as its bed on the maps. During half the year, however, this channel is one day south of the lake. During a recent trip up the Lake Huron shore, north of Thunder Bay, it was one of my objects to examine the reported outlet of this river into Lake Huron. On the south side, and near the head of the deep, crooked bayou, tributary to Little Thunder Bay on the north, is a remarkably deep hole in the otherwise shallow bed of the bay. The entrance of this long arm of Little Thunder Bay is disguised by a long, low island which hangs across it. Any one in coasting would be apt to miss it, as I did at first, unless he followed carefully the indentures of the coast. We had left the head of the bayou, perhaps 150 rods, when there was a sudden increase in the depth of the water. The weeds which had covered the bottom entirely disappeared within a space no more than the length of the boat, and the water was as black as at any place in the open lake. The motion the boat had attained carried us over the chasm, and my pocket thermometer told us the temperature of the water was 67 deg. Fahrenheit. As that was the same as the temperature of the shoal water of the bayou, observed a few minutes before, I was disappointed, for I had expected to detect the presence of river water, if it were the outlet of Sunken Lake, by the difference of temperature between the lake water and that of the water rising from the opening. Pushing the boat astern, we followed the rim of the basin round toward the right, and found the descent very abrupt in all places. When the boat reached the east side of the opening, the weeds were seen to rapidly diminish, and they soon entirely disappeared. Our boat stopped upon the brink at this place, and upon proceeding to make another observation on the temperature of the water, what was our surprise to find that we were slowly drifting away from the opening! It was further observed that we were in motion against the breeze, which was passing up the bayou. I was again surprised to find that the temperature of the water was 65 deg. Fahrenheit. This observation was made perhaps 10 ft. to the east of the opening, and as we were drifting, allowing the boat to continue in motion, the temperature at 30 ft. from the opening was 65 deg. Fahrenheit. The depth of the water at the place of these last observations was not more than 18 or 20 inches, and the bottom was one of clean sand with frequent shells common on the lake beach near the mouth of rivers, but no weeds. Returning to the opening and following the line of shoal water in the same direction, we found that the weeds soon became as abundant as on the other side of the current. The current ceased soon after we passed the most eastward or lakeward side. The opening is six or eight rods across, and nearly circular, and is nearest the south side of the bayou, about 12 rods from the shore. As one passes over the brink and loses sight of the weeds as they descend so quickly down the subaqueous brink, a feeling of terror comes over the beholder, as if he was about to be precipitated into an awful chasm. Fishermen report that a lead has been lowered 300 feet into its opening without a bottom. I suppose the temperature of the water over the opening is higher than that of the current just east, because of the influx of the heated bayou water, and that the real river water is found just over the sandy part of the brink, and a little further east. It was not until I left the place that I remembered that the temperature of the Thunder Bay River at Alpena, at two different observations, was 55 deg. Fahrenheit. In winter this is always free from ice, and ducks frequent the place. I have no doubt but this is the real outlet of the north branch of Thunder Bay River, which disappears in the bed of Sunken Lake."

THE GREAT HUMBOLDT SALT MINE,

NEAR Austin, Nevada, is described by a California paper as looking like a lake frozen over. The salt is as hard and as smooth as ice. Were it not for fine particles which are condensed from vapours arising from beneath, and which cover the crystalline salt to the depth of perhaps one-eighth of an inch, it would make an excellent skating rink at all times of the year, except on the very unfrequent occasions when it is covered with water. The expanse of crystallised salt is no less than twenty miles in length and twelve in width, without a break or flaw for the greater portion of that extent. The stratum of solid salt is about six or seven inches thick, under which comes a layer of sticky, singular-looking mud, about two feet thick, and under this again another stratum of solid salt, as transparent as glass, of which the depth has been found in some parts to be six feet. In summer, this salt plain, glittering and scintillating in the light of an almost tropical sun, presents a brilliant appearance. The frosty covering and the solid salt is as white as the snow, while the crystalline portion, when exposed, reflects dazzling prismatic colours. This immense deposit is remarkably pure, being 95 per cent. of salt and 5 per cent. of soda, which is purer than what we commonly use for our tables.

THE ISTHMUS OF SUEZ.

IT is allowed by all geologists that the Isthmus of Suez is the bed of an ancient sea. But how it became dry has not yet been decided: some observers are of opinion that its present condition is the result of an elevation of the land, while others maintain that the true cause has been a subsidence of the sea. M. Rey de Morande, who has examined the locality, and has published an Essay on the question, says that there is no evidence of elevation of land, and thinks that the sea, which once covered the isthmus, has been gradually dried up.

CAVE DISCOVERIES.

PROFESSOR CAPELLINI, of Bologna, has discovered remains of man and the lower animals in a cavern of the island Calmeria, the access to which is difficult and dangerous. In excavating, he found many implements of flint and stone, the working of which showed that they belonged to the most remote stone age. Besides objects referable to the hand of man, he found many which had been carried there by the human inhabitants of the cave, and a considerable quantity of animal bones mixed with the human. The condition of the latter indicated that the cave had been inhabited by cannibals. In the centre of the cave were traces of a hearth. At Hauteville-sur-Mer a complete underground forest, in which repose trunks of oaks, &c., has been discovered. The oak has preserved its hardness, but the other woods have become quite soft. The submersion beneath the sea is supposed to have taken place in or about the eighth century.

LAKE TAHOE.

ALL who have attempted to swim in the waters of Lake Tahoe must have been startled by their strange lack of buoyancy. Good swimmers launch forth into the lake with the utmost confidence in their skill, and at once find themselves floundering, and only able to keep afloat by the most strenuous exertions. Going into Lake Tahoe after swimming in the generality of lakes—the lakes and streams of the valleys—is like attempting to swim in fresh water after having learnt the art in salt water, or even more trying. The bodies of the persons drowned in the lake are never seen after they have once sunk. Of the five white persons drowned in the lake not a single body has ever been recovered or ever seen. The bones of all are still in the lake. How many Indians may have been lost in its waters in times past no one knows. Pine logs float in the lake but a short time, then sink never again to rise. In places far down through the crystal fluid are to be seen resting upon the bottom great quantities of slabs, logs, and lumber. The specific gravity of the water we do not know. It certainly can hold in solution but a very slight percentage of minerals of any kind.—*Californian Paper.*

HÆMATITE IRON ORE.

PROFESSOR STOKES has read to the British Association the Report of the Committee appointed at the Exeter meeting of the Association for the purpose of calling the attention of the Government to the importance of completing, without delay, the investigation into the composition and geological distribution of the Hæmatite Iron Ores of Great Britain and Ireland, which has been already in part carried out by the Geological Survey. The Report set forth that the committee in calling the attention of the Educational Department of the Government to the subject, pointed out that a remarkable process was invented some years ago by Mr. Bessemer for the conversion of crude cast iron into steel or wrought iron, a process by the application of which important materials could be manufactured at a cheaper rate than formerly. The committee further pointed out that the royalty which at present exists on iron to which the Bessemer process has been applied will shortly expire, and that its expiration will probably give a great impetus to the iron trade of the country, and will give rise to a great demand for hæmatite, as this ore, by its pureness, is the best adapted for the Bessemer process. Therefore, it was most important that it should be known where hæmatite was to be found, and that the investigations already entered upon as to the localities of this ore should be continued.

The result of the application was a reply from the Science and Art Department, to the effect that the Government did not feel itself in a position to continue the investigation of the subject by the Geological Survey, as it had come to the conclusion that the money granted for such survey could not be properly applied for the purpose of the investigation desired by the Association.

The President of the section said that, after this reply, no further steps could be taken on the subject by the committee.

SILVER MINE.

We have before alluded to the Silver Island of the north shore of Lake Superior, in the British Possessions, just below Thunder Cape, and some 15 miles beyond Fort William. The island is quite small in dimensions, say 100 ft. by 40 ft., and most of it is submerged at high water; a small part at one end is about 8 ft. above the lake level. This island was entered by the Montreal Mining Company as part of a tract embracing 108,000 acres. It was only last summer that Captain Frew and his company completed their bargain with the Montreal Company for the island, and secured it by paying, or agreeing to pay, $250,000 for the entire 108,000 acres. They went immediately to work at improving the mine. Their first step was to surround the island with cribs of timber, filled with stone, to serve as a breakwater and an icebreaker; and within these cribs a coffer-dam was built, and puddled with clay, making the whole interior of the island nearly water-tight. Then they went to work laying bare the vein, and now have exposed 70 ft. in length, and find it to be a true fissure vein, with perpendicular walls, the vein of silver matrix being calcareous spar, with some little quartz intermixed. The vein is 8 ft. wide and eye-witnesses from there state that for one quarter of this width it will average 70 per cent. of pure silver. On the first trial, after the water was got out, 6 men took out $35,000 worth of silver in four days; and up to the latest accounts the working has been continued at about this rate. Already 123 barrels of native silver, estimated to be worth $75,000 to $100,000, have been shipped. The yield of the mine, computed by the ton, is not less than $1 to the pound. The mine now employs about 40 men, and the company will increase their force immediately.—*Duluth Minnesotian.*

GREAT MINING GALLERY IN BRUNSWICK.

A great underground work is the Ernst August Gallery—one of five belonging to a metal mine in the Hartz. The mouth of it is at Gittelda, in Brunswick. It is 10 ft. high, 6½ ft. wide, and has a fall three-fifths of an inch in a yard. Like a railway tunnel (but it is twice the length of the longest), it was begun simultaneously at various different points, and finished in 13 years. The gallery is 6¾ miles in direct length; but if its lateral branches are taken into account, and a subterranean gallery navigable for boats, which opens into it, the Ernst August Galleries are said to be not less than 15 miles long. All the junctions of the different sections fit accurately into each other, the precision of the results having been partly insured by the aid of a magnet, weighing 200 lb., which influenced the compass through the solid rock 65 ft. deep, and which was kept in one of the working-places, while the compass was held in the other.—*American Railway Times.*

THE NEW COLORADO MINES.

According to the correspondence of the *Chicago Tribune*, the excitement caused by the discovery of these mines is very great:—"Fifteen hundred would be a low estimate of the people already arrived, where, one month ago, a single cabin was the only evidence of the white man. The Grand Island district is situated about twenty miles from Central City, between the North and South Boulders, very near to the Snowy Range. It is on the same silver belt that has been found at White Pine, on the north of us, and in Arizona on the south. The prospectors who discovered it were guided, in a great measure, by these regions. They have undoubtedly found one of the richest silver mining districts ever known Old White Piners say that the ore is not only more valuable than that taken out in Nevada, but also that there is more of it. While many claims have been taken up, and some opened, there still seems to be plenty for all. Ore from the Cariboo and Idaho leads has been sent to the smelting works at Central City for reduction, and paid very largely, one lot assaying 3,000 ounces to the ton. But it is questionable if much can be done in developing the mines this fall and winter, owing to the heavy snows, which will soon cover up everything. Grand Island, though only a month old, boasts of several stores and two hotels. It would rather astonish people in the cities to see the goods in the former, and to partake of the accommodations of the latter. The merchants have everything for sale needed in a mining camp, from machinery down to needles and thread. The hotels offer you a blanket and a soft place on the rough board floor, and charge as if you were facing the handsome and polished cashier at the Sherman House. The miners themselves build cabins, buy their own provisions, do their own cooking, and are entirely independent. They usually pair off, and two of them live together, work together, and have everything in common. The largest mine yet opened keeps six teams hauling to Central City, and many of them require from two to three. Many who own interests here have gone to Chicago to get machinery, and as soon as it arrives and can be put into operation the yield will be largely increased. But, as before said, it is doubtful if much will be done, or can be done, before spring. When the snow begins to fall in any quantity, the roads must be so blocked up that it will be next to impossible to make any progress over them. The ores cannot then be hauled to the works, and machinery and supplies cannot be conveyed to the mines. All prospecting must cease, as it would be rather difficult to accomplish anything in the way of discovery with from ten to twelve feet of snow on the ground. The oldest lead in the district is the 'Cariboo.' This mine has reached a depth of 75 feet. Two different ores have been taken out, which vary considerably in price. The select ore, as the best is called, is worth from $550 to $750 per ton. The common or inferior ore sells readily for about $200 per ton. How much these ores are strictly worth cannot be ascertained. Professor Hill, to whose works in Blackhawk they have always been taken, buys them from the proprietors of the mine, and reduces them as his own. Of course, he must be realising a handsome profit, as he is anxious to obtain the ore as fast as it can be taken out. $125,000 has been refused by the owners of the 'Cariboo' lead for their interests, which proves beyond a doubt that they entertain a high opinion of the value of the mines. The next in order of discovery is the 'Idaho' lead, and the great enthusiasm which has broken out for Grand Island is due principally to the richness of the ore taken from the 'Idaho.' This mine was discovered in August, and at the depth of 17 ft. a pay-vein was struck 42 in. wide. Never, in the history of silver mining on this continent, has a vein been found at once so extensive and rich so near to the surface."

EARTHQUAKE AT SANTA MAURA.

SANTA MAURA has been almost destroyed by Earthquake. The shocks were so violent and so numerous that almost the entire town was destroyed. The earthquake was felt with severity at Monteleone, Pizza, Philadelphia, and elsewhere in the group of islands. In the town of Monteleone several houses were so damaged that they were in a dangerous state, and had to be vacated. A violent shock of earthquake was felt at Smyrna on the evening of December 1, but no damage was effected. At Mantechè, opposite the Sporadi, on the contrary, the shocks occasioned serious consequences. The town of Ula was destroyed, and three men were killed. Mamaritza and Mula suffered enormous injury.

Santa Maura, or Leucadia, in which the ruined city stood, is one of the Ionian Islands. A chain of limestone mountains intersect it from north to south, covering the surface with its spurs, and terminating south-west in the promontory famous as "Sappho's Leap." Mount St. Elias, in the centre, is 3,000 ft. in height.

GREAT EARTHQUAKE IN MEXICO.

AT Oaxaca, Mexico, the night of May 11, 1870, will be one long remembered. At half-past 11 o'clock, A.M., a succession of shocks of Earthquakes occurred which shook the city to its foundation, causing a large number of deaths, and the almost entire demolition of the southern part of the city. The movement at first was oscillating from south to north, and almost instantaneously followed by a vertical one. Oaxaca dates back 200 years, but bears no scars which can compare with those above inflicted. There is no city in Mexico, probably none on this continent, more substantially and solidly built than Oaxaca; yet there is not one house or edifice which has not suffered more or less, while many are in absolute ruins. The whole of the corridors of the old convent of San Juan de Dios are down, and in their fall buried four persons, wounding and maiming many more. San Francisco, inside and out, is a heap of rubbish. The palace is almost in ruins. The clock-tower, which was only completed on May 5, came down bodily, passed through the roof into the halls of the Supreme Court, through the floor of these, and piled itself in the portal of the palace underneath. The whole of the arches are sprung, and many of the columns are shifted 8 in. and 10 in. on their pedestals. The cathedral in its interior suffered most severely, and the saint perched upon the top over the centre door came down with a crash. The total number of deaths known thus far is 103; the wounded and the maimed it is impossible to find out. The shocks continued at intervals throughout next day.

We cross a hemisphere of ocean, but not departing greatly from the latitude of Mexico, and we read in the *Yokohama Herald* of May 22:—"The earthquake on the 13th, at about half-past 2 A.M., was one of the most violent felt since the calamity of 1855. The houses rocked alarmingly for about a minute and a half, plaster being dislodged, paper burst from the partitions, and stones cracked, or were utterly thrust out from the walls. The master of the schooner *Anna* reports that while we were experiencing this smart shock his vessel was coming up the Gulf of Yedo, between Kanonsaki and Treaty Point, when a concussion was felt as if the ship had struck a rock; the lead was immediately hove, and found 15 fathoms of water. About a quarter-past three a lighter shock was felt. The water was smooth and the wind light at the time; but immediately after the shock the vessel swung completely round, being immersed in a temporary vortex In the vicinity of Vries Island large fields of pumice-stone were noticed floating round, samples of which Captain Peterson brought on shore. There is little doubt that the volcano on Vries Island acts as a safety-valve for the neighbourhood, as shocks of earthquake are mostly accompanied by increased action on the part of the volcano. A gentleman who has completed an overland journey from Niigata says the shock was still more severely felt in the interior of the country, and threw the Japanese into great alarm. Their terror was heightened by an eruption of the great volcano Asayama, in the province of Sinshiu, which has not been in actual eruption for three or four centuries."

ERUPTION OF CEBORUCO.

THE Mexican Correspondent of the San Francisco *Bulletin* gives particulars of an Eruption of Ceboruco. About fifteen miles north of Ahuacatlan is situated the mountain of Ceboruco, which on February 22 burst forth into five distinct volcanoes, vomiting ashes, sand, and large rocks with such violence and continuity as to cause the depopulation of the surrounding country. A white smoke is visible throughout the day; at night a blue sulphurous light, with occasional flames, crowns the summit of the sierra; at intervals of ten or fifteen minutes puffs of, apparently, vapour are emitted, with a sound like that of the blowing off of steam from a boiler, followed by a dull roaring noise and trembling of the earth. The liquefied rocks and earth run like creeks of water. The eruption, if continued, will endanger the town of Ahuacatlan. The inhabitants of the towns and villages in the vicinity could not breathe, from the effects of the fine ashes, which cover the ground and roofs of houses to the depth of over 1 in. The fires are extending in the direction of Uzeta and Tequepeshan. Jala is in imminent danger. In close proximity to the present eruption the remains of an old extinct crater are distinctly visible, evidently having in its day far exceeded the powers of the late outbreak; a stream of lava, two miles wide by twelve miles long, presenting at a distant view the appearance of a wide carriage-road, descends from the old opening and terminates on the road, which creates a hollow, rumbling sound when passed over by the stage coach. To date of April 1 no cessation or diminution had been perceived; on the contrary, it was presumed to be augmenting in force and extent. The Indians in the neighbourhood believe it to be a vast gold and silver mine, and that the imps of darkness are having a grand production of metals; they profess to see black people in the blue flames, making merry over their productions at night.

In a lecture lately delivered by Mr. Forbes, upon volcanoes, it is stated that the formation of a new, or the reopening of an old, volcanic vent is usually accompanied by a terrific explosion, often to be heard at immense distances. Thus, in 1812, the outburst of the volcano at St. Vincent was heard in South America, 700 miles distant. In the eruption of Ararat, in 1840, masses of rock weighing twenty-five tons were thrown out. Cotopaxi is said to have hurled a 200-ton rock.

NEW FOSSIL FISH.

A FOSSIL FISH, 22 inches long, has been found in the Lower Flag Rock of Lancashire. Mr. Aitken, of Bacup, President of the Manchester Geological Society, the owner of the fossil, considers the fish to be a new species, and remarks that its discovery is peculiarly interesting, as hitherto no animal remains have been found in this stratum.—*Athenæum.*

SILURIAN TRILOBITES.

There has been read to the Geological Society "Notes on some Specimens of Lower Silurian Trilobites," by Mr. E. Billings. The author first described a specimen of *Asaphus platycephalus*, in which the hypostome was not only preserved *in situ*, but also the remains (more or less well preserved) of eight pairs of legs, corresponding with the eight segments of the thorax, to the underside of which they had been attached. Mr. Billings next described the doublure or pleura in the trilobites, comparing it to that of Limulus, and then a row of small scars and tubercles on the underside of the pleuræ. Mr. Billings next directed attention to the Protichnites and Climactichnites; and, finally, he described a section of a rolled-up *Calymene senaria*; the interior cavity of which appears to be full of minute ovate bodies, from 1-80th to 1-100th of an inch in diameter.

CIRCUM-POLAR FOSSIL PLANTS.

The recent discoveries of enormous deposits of fossil plants in high northern latitudes will, as Sir E Sabine justly observes, in his annual address to the Royal Society, impart a new and interesting motive to future explorers of the circum-polar lands. The paper by Dr. Oswald Heer, of Zurich, published in the *Philosophical Transactions* for 1869, has added much to the evidence contained in former papers by that able palæontologist of the existence in remote geological epochs of "a vegetation in some cases identical with, and in others scarcely differing from, that which now lives and flourishes in the temperate zone—a vegetation comprehending oaks, planes, chestnuts, and even a magnolia, the leaves and fruit of which were found in the North Greenland deposits. In all, Professor Heer has identified no less than 137 species of the Arctic flora of the Miocene age; and he has moreover inferred, with great appearance of reason, that at the same era vegetation of the same character may have prevailed generally in lands within the Arctic Circle. The anticipation of future discoveries of plant-remains, adding possibly largely to the number of 137 species already recognised, must tend to give to land explorations and excursions an interest which was comparatively wanting to them when all that the explorer could anywhere hope to find (other than the scanty, though in some respects beautiful, flora which the rigours of the Arctic region at the present time still suffer to exist) was at most the less attractive fossil remains of much earlier geological ages, to the climatology of which less interest attaches than to that of the comparatively recent (however ancient) Miocene age."

CETIOSAURUS.

Professor Phillips has addressed to the *Athenæum* the following very interesting communication:—"University Museum, Oxford, March 22, 1870: Since the discovery of the huge thigh-bone of this great lizard, about a year has passed in the slow working of the quarries, with no important additions beyond a few caudal vertebræ. Quite lately, however, notice reached me ('nostras pervenit ad aures') of several bones of large size, lying on or near to the surface of oolite where the great femur rested; and I have made several examinations of the locality and circumstances of the deposit. On the last occasion, my friend, Mr. James Parker, was with me, and gave excellent aid in the 'survey.' The space of ground in which the bones are found is apparently quite limited. They lie pretty near together, but not in their natural relative situations. All have been drifted, yet not so much as to have suffered by attrition or mutual fracture. One may think the whole body of the vast old lizard, in the extremity of age, was here laid to uneasy rest; the parts separated by decay, the massive limbs disjointed, and the bones displaced. They lie in, and in some degree constitute, a bone-bed, whose basis is clay, with abundance of carbonaceous matter and small masses of wood which has undergone 'eremacausis.' Selenite, the natural result of the mutual action of iron-sulphide and decaying wood, in presence of calcareous matter, is rather too abundant, and injures the firmness of the bones occasionally.

"Imagine a surface of the ossiferous clay which covers the oolite laid bare by the workmen. Look southward; before you are four bones laid rudely parallel, in a row, at intervals of 1. 2, or 3 feet. They are 64, 54, 45, and 37 inches long; 10 inches the least breadth in the narrowest part; 26 inches the greatest breadth in the widest part. These are bones of Cetiosaurus. Over them and in front of them, three days since, lay as many others, as large, and as quietly reposing in their 'longæval' graves; behind them, possibly, are still more bones, to be discovered at some future time. Bones of a much mightier area—probably hugest of all huge ilia—extended far and wide; vertebræ, 8, 9, and 11 inches in diameter; monstrous ribs, of which the parts traceable and inferred are 59 inches long; and to this must be added two unknown quantities; so their length must have been $y + 59 + x$ inches; all this within the compass of a few square yards. It seems like the burial-place of the great father of lizards, each of whose bones demanded—but only some could obtain—a separate grave. To reconstruct the framework of bones by replacing the many hundreds of fragments (for they are all traversed by innumerable fractures, and can only be taken up in heaps of chips mixed with some large frusta) will be the work of many months in our Museum. There, it may be hoped, for many an age, 'dum stabit Capitolium'—while Parliament will let us alone—the student of ancient life

will pause before the collected remains of perhaps the largest animal that ever walked upon the earth, and congratulate himself that he lives in mammaliferous, not megalosaurian days—

> **"Et grandia effossis mirabitur ossa sepulchris.**

"John Phillips."

ORGANIC REMAINS IN TRINIDAD.

A paper has been read to the Geological Society "On the Discovery of Organic Remains in the Caribean Series of Trinidad," by Mr. R. J. Lechmere Guppy. The author described the rocks of the "Caribean Group" as consisting of gneiss, gneissose, talcose, and micaceous slates, and crystalline and compact limestones, and remarked upon the probable distribution of rocks of the same series on the continent of South America. In Trinidad the uppermost member of the series is a compact dark blue limestone, which contains obscure, but abundant, fossils; in the subjacent clay-slates and quartz rocks calcareous strings and bands, containing more distinct traces of organisms, occur. The author believed that he had detected an Eozoon (which he called *E. caribeum*), a Favosites (named *F. fenestralis*), a coral, and fragments of Echinoderms. He considered it probable that the Caribean series was pre-Silurian.

FOSSILS OF AUTUN.

M. B. Renault, Professor of Chemistry in the Scientific School of Cluny, has discovered a number of plants in the fossils of Autun, differing from those already noticed. Careful examination under the microscope of well-preserved stems of *Zygopteris* and *Anachoropteris* shows differences between those plants and ferns of the present day, but not sufficiently to dissever these varieties from the family. M. Renault has also succeeded in recognising plants of the genus *Lycopodium* in some small fossil remains, thus showing the existence in ancient formations of a genus of plants not found in the French coal-fields, and rarely in those of other countries.—*Athenæum.*

FOSSILS IN SICILY AND CALABRIA.

"Remarks on Newer Tertiary Fossils in Sicily and Calabria" have been read to the British Association by Mr. J. Gwyn Jeffreys: In the last deep-sea exploring expedition in H.M.S. *Porcupine*, in the Bay of Biscay and along the Atlantic coasts of Spain and Portugal, Mr. Jeffreys procured at considerable depths, and especially from 994 fathoms, many species of mollusca in a living or recent state, some of which had been previously regarded as fossil only, and extinct, and all of them belonging to the newer tertiaries of Sicily and Calabria; and he believed that a record of the fact might lead to the further discovery of the geological phenomena which had caused the fossilisation of such species in that limited area. Several of these species inhabit northern, and even Arctic seas, and among them are *Terebratula cranium*, *T. septata*, *Rhynchonella psittacea*, *Pecten aratus*, *P. vitreus*, *Lima excavata*, *Mytilus vitreus*, *Leda frigida*, *Limopsis aurita*, *L. minata* or *borealis*, *Dentalium abyssorum*, *Puncturella noachina*, *Hela tenella*, and *Pleurotoma carinata*. Other species now found in a living or recent state are *Terebratula sphenoïdea*, *Tellina striatula* or *strigilata*, *Verticordia acuticostata*, *V. granulosa* (the two last being Japanese), two species of Fissurisepta, *Trochus suturalis*, *T. glabratus* (Turbo), *Trochocochlea monocingulata*, *Scalaria pumila*, *Cyclostoma delicatum* (*reclusia*?), and *Pleurotoma decussata*. One of the species in the last list or category (*Fissurisepta papillosa*) had been also dredged by Mr. Jeffreys last autumn at Dröbal, in Norway; and he was of opinion that our knowledge of the Arctic marine fauna was very imperfect. The newer Tertiary fossils of Sicily and Calabria had been to a great extent investigated by Dr. Philippi, formerly of Cassel, Prof. Seguenza, of Messina, the Abbé Brugnone, of Palermo, and Dr. Tiberi, of Resina, near Naples, and their collections had been examined by Mr. Jeffreys. Two suggestions or questions were submitted by the author of the present paper, viz., 1st, Have not all the deep-sea species of European mollusca originated in the north, and spread southwards in consequence of the great Arctic current? 2nd, Inasmuch as the Pliocene division of the Tertiary formation is now ascertained to contain scarcely any extinct species, and future explorations may reduce the percentage of such species to nil, may not that artificial division hereafter merge in the Quaternary formation, and the Tertiaries be restricted to Eocene, Miocene, and Oligocene?

The President and Sir Roderick Murchison spoke of the great importance of this communication; and the latter hoped Mr. Jeffreys did not share the opinion of his colleague Dr. Carpenter, that their discoveries tended to upset modern geology. Prof. Duncan confirmed Mr. Jeffreys' statement with respect to the specific identity of corals from deep water with those of the South Italian Tertiaries. The Rev. H. W. Crosskey also addressed the section as to the glacial fossils of Scotland being Quaternary, and not Tertiary. Mr. Jeffreys, in reply, begged to assure Sir Roderick, as one of the parents of English geology, that he need not be under any apprehension for his offspring, so far as the deep-sea explorations were concerned.

PALÆONTOLOGY OF GLOUCESTERSHIRE.

A PAPER has been read to the Geological Society "On the Palæontology of the Junction-beds of the Lower and Middle Lias in Gloucestershire," by Mr. R. Tate. The author's object was to show that the attachment of the zone of *Ammonites raricostatus* to the Lower Lias and that of *A. Jamesoni* to the Middle Lias harmonises with the distribution of the organic remains; 50 species were catalogued from the united zones of *A. oxynotus* and *A. raricostatus*, 8 of which pass up into the Middle Lias, whilst 13 occur in the lower horizons; 115 species were enumerated as occurring in the zone of *Ammonites Jamesoni*, 60 of which pass to higher zones, whilst 11 made their first appearance in the Lower Lias, the number of species common to the contiguous zones being 14. The author inferred that as the conditions of depth and deposit of the upper part of the Lower Lias are repeated in the lower part of the Middle Lias, accompanied by a total change in the fauna, a break in the stratigraphical succession existed between the Lower and Middle Lias.

PENTACRINUS FROM THE COASTS OF SPAIN.

Mr. GWYN JEFFREYS has presented to the British Association this fossil as one of the results of a dredging cruise in H.M.S. *Porcupine*. The Pentacrinus is different from *P. caput Medusæ*, its nearest congener being *P. Mulleri*. Its base was free, although imbedded in the mud. It is the first and only instance of a European species of this genus, which forms such an important link in the geological chain, and connects the Mesozoic with the present epoch.

Professor Wyville Thomson regards this as a most remarkable and valuable discovery, and has made some remarks on the zoological position and history of the genus. Mr. Jeffreys adds that he noticed in Professor Seguenza's extensive collection of Tertiary fossils from the Zanolean formation at Messina some joints of a Pentacrinus, which probably belonged to *P. Wyville-Thomsoni*.

RHINOCEROS REMAINS.

A PAPER has been read to the British Association "On the Species of Rhinoceros whose Remains were discovered in a Fissure-cavern at Oreston in 1816," by Mr. G. Busk. The object of this paper was to show that the rhinoceros whose remains were discovered by Mr. Whidbey in a fissure-cavern at Oreston, near Plymouth, in the year 1816, and described by Sir Everard Home in the *Philosophical Transactions* for 1817, belonged, not, as has hitherto been supposed by every one except the late Dr. Falconer, to *Rhinoceros tichorhinus*, but to *R. leptorhinus*, Cuv. (*R. megarhinus*, Christ.). The remains consisting of between 30 and 40 more or less broken portions of the teeth and bones of the skeleton, most of which are hardly in a condition to afford satisfactory diagnostic specific characters, Mr. Busk confined himself to the teeth and to a perfect metacarpal bone. The teeth mainly relied upon were the first or second upper molars (m^1 or m^2) of the right and left sides. Both were broken, but what was wanting in one was supplied by the other. The thinness and smoothness of the enamel, the configuration of the dorsal surface, the form and size of the columns, and the disposition and relations of the "uncus" and "*pecten*" ("*crochet*" and "anterior combing-plate"), and the absence of the characteristic "*ticho-rhine pit*" or *fossette* were in favour of the author's hypothesis. The metacarpal bone is 9½ in. long, and remarkable for the compression of the shaft and its comparative slenderness as contrasted with the same bone in *R. tichorhinus*, which in no case within the author's knowledge exceeds 7½ or ·8 in. in length, and is proportionately much thicker than in *R. leptorhinus*, or any other extinct species. It was further shown that the Oreston metacarpal exactly corresponded with those of *R. leptorhinus* from Grays Thurrock, in the British Museum. The chairman remarked that at one time the Oreston rhinoceros was referred to *R. tichorhinus*, but that Buckland, although mentioning the rhinoceros, never gave it a specific name. Mr. Boyd Dawkins confirmed Professor Busk's determination.

THE TERRESTRIAL PARADISE.

MAJOR-GENERAL SIR HENRY RAWLINSON has read to the British Association "Notes on the Site of the Terrestrial Paradise." In this paper the author propounded, as the result of his investigations of Semitic antiquities, and of the cuneiform tablets of Babylonia, a new hypothesis regarding the site of the traditional Garden of Eden of the Hebrews. He remarked, in the first place, that on examining the early traditions of nations, we invariably found the Heaven-land, the abode of the gods, the connecting link between divinity and humanity, to lie in that region of the earth from which the recording race took its intellectual origin. In illustration of this, he need only to refer to the Olympus of the Greeks and the Meru of the Aryans, which latter had three sites, according to the habitat of the three branches of the Aryan race; the Persians, or Western Aryans, placing their Iran-vij in the Paropamisus, while the Meru of the Central Aryans was in Pamir, and the Eastern about the Sacred Lakes in Thibet, and in each of these there were supposed to be four rivers flowing from a common centre. There was ground then for supposing the Paradise of the Hebrews to lie in that region which was the cradle of the nation, namely, near Ur of the Chaldees, which the author had been able to demonstrate, from cuneiform inscriptions, to have been situated on the lower Euphrates, at the place now called Mugheir. The name of "Hebrew" was also derived from the same locality, the zone or belt of alluvial land between the river and the Tertiary formation having the specific title among the Arabian geographers of *Ibr*, or "the bank," so that *Ibri* was a perfectly correct ethnic title for the Abrahamic emigrants. Further, the author suggested that *Gan-eden*, which we translate Garden of Eden, was nothing more than the Hebrew rendering of one of the old vernacular names of Babylonia, which was *Gan-duni* (or with the case-ending *Gana-duniyas*) *Gana*, signifying apparently an enclosure, while *Duni*, or *Aduni*, was one of the earliest gods worshipped in the country. Without, however, insisting on this identification of the name, he would rely mainly on the names and attributes of the four rivers which watered the garden, and which were evidently intended to furnish an exact geographical description of Eden. These rivers, as it is well known, were Pison, Gihun, Hiddekal, and Euphrates. Now the land of Babylonia was constantly illustrated in the cuneiform inscriptions by the names of four rivers, two of which answer to the Tigris and the Euphrates, and the other two were named the *Surrapi* and the *Ukni.* The latter two were Assyrian terms, and their Babylonian equivalents had not yet been identified. The *Surrapi* seemed, however, to answer partly to the Biblical Gihon, and the *Ukni* to the Pison, and they represented respectively the left hand, or eastern, arm of the Tigris, and the right hand, or western, arm of the Euphrates. Regarding the Pison, it is said in Genesis, "The name of the first is Pison: that is it which compasseth the whole land of Havilah, where there is gold; and the gold of that land is good: there is bdellium and the onyx there." The name *Pisun*, coming from the Hebrew verb "to disperse," signifies "the overflow," and as in all ages there has been an outlet to the Euphrates above Babylon, where the flood drains off to the south-east, varying exceedingly in its course and names, and as *Ukni* had been shown on independent grounds to mean the Onyx, or the Onyx River, though probably the term really refers to alabaster, quarries of which existed just outside the Euphrates alluvium, the author considered there was good reason for identifying the stream with the Pison of Genesis. Bdellium he considered to mean pearls (Bedolat), which were obtained through this direction, from the Persian Gulf. The land of Havilah he believed to be the strip of sandy desert which skirts the Arabian upland. With regard to the Gihun, or the river "which encompasseth the whole land of Cush," his theory was, that in very early times the left branch of the Euphrates, which left the main river just above Babylon, and ran due east to the Tigris, was considered to be the same as the left arm of the Tigris itself, that arm being prolonged in the same line to the eastward, while the right arm of the Tigris was considered to be the true continuation of the upper course of the river, following the same general direction of south-east. In a rough way, it might be said that the left arm of the Euphrates thus crossed the Tigris, and formed the Gihun. He justified this theory on philological grounds, and discussed the whole subject in some detail. As to the description of the Gihun as "encompassing the whole land of Cush" (which, by a very bold guess, our translators had rendered Ethiopia), "Cush," or "Kish," was one of the primitive capitals of Babylonia, and it gave its name apparently to the whole country along the river. *Kusiya* was mentioned in that quarter among the possessions of Darius Hystaspes. Various other reasons for this identification were adduced. The third river offered fewer difficulties, as no one had ever doubted that the "Hiddekal" was the Tigris. The fourth river was *Perat*, or the Euphrates. In the inscriptions the word is often represented by the sign for "water," in the same way as it is called in Scripture "the great river;" but usually the upper river has the name of *Purat*, where we have probably a very ancient root, signifying "to abound" or "fructify," common to both the Aryan and Semitic tongues; the lower river, below the Pison branch, is called in the inscriptions the river of Sippara, from the town of that name.

OUT OF THE WORLD.

THE *Sydney Morning Herald* supplies the following curious facts respecting Lord Howe Island, which is situated in latitude 31 S., longitude 159 E., and is about 450 miles from Sydney:—

It is sixteen miles in circumference, six miles and a half in length, and averages about half a mile in breadth. About one-third of the island is taken up by two mountains at the south end, which descend in some places perpendicularly to the water. One of these rocks, called Paul's Pyramid, from its peculiar shape, is about 2,500 ft. above the level of the sea. There is a kind of harbour at the south-west side of the island, protected from the swell by a bar about three-quarters of a mile from the shore. The island is well timbered in every direction. It is inhabited by about thirty-five persons, including children. There are, however, only about eight or ten able-bodied young men. The island was, in years gone by, used as a calling station for whalers; and it was with the view of trading with whalers, it is said, that the first settlers were induced to make it their home. The islanders live very peaceably together, although they have no laws, nor anyone to superintend or guide them. There is neither schoolmaster nor clergyman on the island. The inhabitants live in a state of blissful ignorance as to what takes place in other parts of the world. There seems to be a tacit understanding among themselves to respect each other's property. No register of births and deaths is kept, and marriage, in a legal sense, cannot be performed. One remarkable fact which struck some of the visitors was the indifference on the part of the islanders with regard to what was going on in the colonies or elsewhere, and their disinclination to ask questions concerning other countries. Except in one or two instances, they manifested no desire whatever to leave their island home. Most of the people are English, or natives of one or other of the Australian colonies. They were strongly advised by Captain Cloete and the gentlemen who visited the island with him to keep a register of the births and deaths; and they adopted the advice, and appointed Captain Spurling to perform that duty. Now that the wants of the island have been more prominently brought under the notice of the Government, steps will probably be taken to amend the present state of things existing there, and to induce the people to provide means for educating their children.

Some of the houses are good substantial buildings, built of hardwood slabs; others are constructed of palm-trees, and covered with palm-leaves. The palm-trees grow luxuriantly everywhere, and houses are frequently surrounded with them. No manufactures are carried on—everything, both in the way of furniture and implements, being imported At the time of the visit of the Commission, the islanders were all decently clothed. There is a small vessel, belonging to two or three parties on the island, which trades to Sydney about three or four times every year, bringing produce and taking back flour and such other commodities as are required. This is the only direct communication which takes place between the island and this continent. Occasionally a vessel calls at the island, and exchanges of goods and produce then take place. They generally barter their goods for produce which they require, and seldom either give or take money for anything. They occasionally run short of flour, biscuits, and sugar; but they always have plenty of other food.

The island is overrun with great numbers of pigs and goats. The pigs roam about in a wild state and feed on palm-seed, and their flesh is said to be very good eating and of good flavour. There are also great quantities of poultry of almost every kind. The chief products of the island are onions (some of which annually find their way to this colony), potatoes, maize, and bananas. The vegetation resembles in a great measure that of tropical lands. Amongst the trees are to be found the banyan. One specimen of this kind of tree is said to cover about an acre and a half. The soil is rich and capable of producing plants either of a tropical or semi-tropical character. The ground is of an undulating character, cultivation taking place chiefly on the lower ground.

A correspondent (Mr. John Brazier, formerly conchologist to her Majesty's steamer *Curaçoa*) sends us the following particulars:—"The island was not inhabited until about thirty years ago, when a European family landed, and lived on it for seventeen years. When he was there in 1855, there were thirty-three Europeans with their wives. At that time there was plenty of water, fish, fowls, birds, pigs, and goats. The greater part of the settlers on Lord Howe Island are old whaling captains and sailors who leave their ships. Nothing was known of the natural history of the island until the late Mr. John Macgillivray, formerly naturalist to H.M.S. *Rattlesnake* and *Herald*, visited it in 1851, and discovered the following species of molluscan land fauna: four species of the genus Helix, one of the genus Bulimus, four of the genus Diplommatina, one of the genus Cyclophorous, one of the genus Registoma, and one of the genus Omphalotropis. The island is a general rendezvous for the colonial and foreign whalers to get fresh provisions, such as onions, potatoes, &c. These things are generally given in exchange for liquors. This island is not the one that was discovered by Captain Wallis on July 30, 1766. The one discovered by Wallis is in latitude 10·49 S., longitude 166·1 E."

IMPROVEMENTS IN SEPARATING SILVER FROM ORES.

In the extraction of copper from Spanish and Portuguese pyrites and similar ores by the ordinary humid process, that is, by roasting the ground burnt ore with common salt or other chlorides, and subsequently lixiviating the product, the lye contains copper together with a little silver and small quantities of some other metals.

Hitherto this silver has been precipitated along with the copper by means of metallic iron, and their separation has been attempted in various ways.

Now, according to an invention just patented by Mr. F. Claudet, of Coleman Street, London, the silver is separated previous to the precipitation of the copper, and this is done by adding to what are technically called the copper liquors a substance which decomposes the chloride of silver dissolved in them, and which by combining with the silver forms iodide of silver. A soluble iodide of potassium effects this object by transforming the dissolved chloride of silver into iodide of silver. If at the same time the liquors be slightly diluted a precipitate of subchloride of copper ensues. This precipitate carries down with it the insoluble iodide of silver formed. The blowing of steam through the liquors will facilitate the proper admixture of the iodide solution with them.

From numerous trials it has been found that the proportion of silver to copper in Portuguese pyrites is about eight parts in 10,000 parts; an estimation of the copper present in solution therefore affords in this case an easy method of ascertaining the quantity of soluble iodide to be added so as to avoid an excess. After the addition of the iodide the liquors are, as before stated, diluted with water until they become slightly turbid, and are then blown up with steam and afterwards allowed to settle. The clear liquor is now drawn off to the precipitating tanks, whilst the sediment contains the silver as iodide of silver, together with subchloride and oxychloride of copper, some lead, salts, and oxides of iron.

The subchloride and oxychloride of copper are dissolved out in the sediment by means of very weak hydrochloric acid. After washing, the sediment is heated with water and metallic zinc added. The iodide of siver is reduced to the metallic state, whilst soluble iodide of zinc is formed. This is separated from the deposit by filtration or otherwise, and the amount of iodine in solution determined. The iodide of zinc thus produced is now used over again for precipitating a fresh quantity of silver from the copper liquors, although in the first instance iodide of potassium is the salt preferred. In this way the iodine is continually worked over, and comparatively only a small loss of that substance has to be provided for.—*Mechanics' Magazine.*

NEW GOLD-FIELDS IN BRITISH COLUMBIA.

It is stated in the *Times* of January 16, 1871, that new Gold-fields have been found recently at Germansen Creek and Omineca, in British Columbia, which are said to be richer and larger than any gold-diggings found on the Pacific coast since the extraordinary early days of California. Two routes are open to these fields—one by the Fraser River, which is the longer; and the other by the Skeena, or the coast route. The *Victoria Standard* of December 14 vouches for the truth of the following account:—"By the arrival of the steamer *Otter*, from Skeena River, bringing a number of miners from Germansen Creek as passengers, we learn from Mr. White, one of the first party who was on Germansen Creek after the discovery, the following facts in regard to the mines in that country. Mr. J. I. White is an old miner of twenty years' experience. He was in California in early days, and in Cariboo from the first excitement. Mr. White and his partner, 'Black Jack,' started early last spring for the Omineca country. They arrived at Vitalle Creek and prospected for 45 days in and around the neighbourhood of that creek, but did not find gold in sufficient quantities to pay. Their attention was next directed to Nation River, and they started with four months' supply of provisions, prospected there about three months, and did not find gold enough to justify them in stopping there. They left and then struck the Omineca River, which they travelled up about 100 miles, prospecting several creeks which emptied into the river, and found gold. Mr. White thinks that some of these creeks will pay as well as Germansen Creek. They then struck Germansen Creek, which empties into the Omineca River. There they found a party who had discovered the creek about two weeks previously. They prospected the creek, found gold in paying quantities, and located their ground. As far as the creek has been prospected, it has paid from $10 to $100 per day to the hand. By the time Mr. White got his flume ready for work the creek was frozen, and he had to discontinue further operations. There is not much difference in the pay of the claims as prospected, which extend 2 miles. The creek is supposed to be from 25 to 30 miles in length, but the exact length is not known, as it has only been prospected a very short distance. All the claims which were opened up the creek paid as largely as those which were worked lower down the creek. A new creek was reported to be discovered about 10 miles from Germansen, which prospected 25 cents. to the pan. It also empties into the Omineca. The country is mountainous, thickly wooded, with lakes and beaver dams all through it, and it is a very rough country to prospect. The opinion of an old miner is that it is the best gold-field which has yet been struck on the coast, especially for a poor man. The gold taken out up to the time our informant left amounted to about $100,000, most of which went for provisions."

Astronomy and Meteorology.

THE REPORT OF THE ASTRONOMER ROYAL.

THERE is a portion of the Report of the Astronomer Royal to the Board of Visitors of Greenwich Observatory to which we desire to call attention. Mr. Airy raises the question whether the cause of science might not gain if at Greenwich Observatory, as in the Imperial Observatory of Paris, for instance, the higher branches of mathematical physics should take their place by the side of observatory routine. This is a question of much importance, and we sincerely hope that the remark of the Astronomer Royal will attract the attention of those interested in such matters. All know the valuable investigations which Mr. Airy has himself made in the lunar theory and physical optics; but it is, perhaps, only those who are acquainted with the immense routine duty and the amount of daily labour entailed on the Astronomer Royal himself who can appreciate justly the difficulties with which Mr. Airy has to contend in following out such pursuits, or in undertaking any investigations which do not fit in necessarily with the routine of the place. The chief object of a great national observatory like that at Greenwich is to ascertain and register the positions of the heavenly bodies. Such work is a national necessity, and its practical utility is incalculably great. There probably never was an observatory which fulfilled its duties so well as Greenwich Observatory now does, and has long done, under the care of the present indefatigable Astronomer Royal. There are other important branches of observation which have grown up, and which may now be regarded as equally the part of a national observatory, namely, magnetic and meteorological observations, and observations on the light and heat of the heavenly bodies. The magnetic and meteorological observations have been conducted at Greenwich for a long time on a large scale, and observations with the spectroscope and thermopile are receiving a continually increasing attention.

HARTWELL-HOUSE OBSERVATORY.

THE valuable astronomical instruments from Hartwell-House Observatory, the property of Dr. Lee, deceased, have been disposed of by Messrs. Christie, Manson, and Woods. The following were the more important objects:—Lot 1. The transit instrument, by Jones, of Charing Cross, 5 ft. focus and 3¾ in. aperture, mounted on stone piers, fitted with Brazilian pebbles, two setting circles, a full battery of eye-pieces, and all necessary apparatus—11 guineas (Hodgson). 2. A sidereal clock, by Vulliamy, of Pall Mall, specially for Dr. Lee, furnished with mercurial pendulum and Graham's dead beat—25*l*. 10*s*. (Page). 4. A Gregorian telescope, with 5 in. speculum and low stand—8 guineas (Harris). 5. An equatorial stand, universal, by Cooke, of York, for a 6 ft. refractor, with a cast-iron stand—14½ guineas (Gibson). A different property.—31. A 42 in. telescope, 2⅞ in. achromatic object-glass by Dolland, with brass pillar and claw stand and mahogany tripod stand (fitted with divided altitude quadrant) to match; the telescope is fitted with finder, telescopic steadying rods, four Huyghenian eye-pieces, magnifying 40, 80, 130, 180 diameters, Kitchener's pancratic eye-tube, magnifying to 300 diameters, double gold-wire micrometer, &c., and all the accompaniments of a first-class telescope, contained in a handsome mahogany case—14½ guineas (Handford). 32. A very rare and beautiful mechanical clock, in a richly chased and gilt case, under shade, and a Spanish mahogany stand, ormolu mounted, with marble slab for same, formerly in the possession of Napoleon I. A similar clock can be seen in the Palace of Versailles—48 guineas (Page). 44. A pair of breech-loading double-barrelled guns, by Purday, in a case—30½ guineas. 45. A pair of ditto, by Charles Lancaster, 35½ guineas.

ASTRONOMICAL NOTES.

AMONG recent communications to the Royal Astronomical Society, Mr. Balfour Stewart throws out the notion that auroral appearances and the zodiacal lights are in some way connected with the phenomena of terrestrial magnetism He finds in the anti-trade winds the moving conductors required to produce the effect, and suggests that as they pass rapidly over the lines of the earth's magnetic force, we may expect them to be the vehicles of an electric current, and possibly to be lit up as attenuated gases are when they conduct electricity. In this way, the phenomenon of the zodiacal light might be produced. Then, again, these moving currents will re-act on the magnetism of the earth, which may account for the somewhat sudden and violent changes that take place in the earth's magnetism at those seasons when the great wind-currents change most rapidly—as, for example, at the equinoxes. May we not also imagine, says Mr. Stewart, that there are two varieties of aurora—one corresponding to stationary conductors under a very rapidly changing core, and the other to rapidly moving conductors under a constant core? And might not an aurora of the latter kind indicate the approach of a change of weather?

Mr. Huggins, pursuing the interesting question, how to render the solar prominences visible without the use of the spectroscope? states that the most promising medium he has yet tried is a solution of carmine in ammonia, combined with a solution of chlorophyll. But this combination requires to be greatly improved before the full effect desired can be obtained. It appears, too, that the spectroscope is likely to play a useful part in observations of the transit of Venus which is to take place in 1874.

—Mr. J. Browning reports a remarkable change of colour in the equatorial belt of Jupiter. During the years that he has observed the planet, "the equatorial cloud-belt has been without colour;" but now it is of a strong greenish yellow, diversified at times by white spots, while the polar regions of the planet are ashy blue. These appearances have been confirmed by other observers, and it is supposed that they indicate some considerable change either on the surface or in the atmosphere of Jupiter.—*Athenæum.*

OCCULTATION OF THE PLANET SATURN.

Mr. W. F. Denning, Hon. Sec. Observing Astronomical Society, writes from Bristol:—The Occultation of Saturn by the moon on Friday last (September 30) was observed under favourable circumstances. The telescope employed was an old metallic-mirror reflector of 4 in. aperture, and with this instrument the planet was distinctly seen as early as 5.30. I watched the gradual approach of the two bodies until 6, when the west part of the ring of the planet was obscured by the moon. At 6.1 (town time) the planet entirely disappeared, and remained invisible for one hour 14 minutes. At 7.15 the ring became visible from the bright side of the lunar disc, and very soon afterwards the planet had completely reappeared. It was exceedingly faint immediately subsequent to its emersion. The dull hue of Saturn contrasted strongly with the bright clear light of the moon. The occurrence would certainly have been witnessed to greater advantage had the objects been situated at a greater altitude. During the progress of the phenomenon the moon was slightly enveloped in a mist.

Occultations of Saturn are of comparatively rare occurrence. In the present year, however, the planet has been obscured by the moon no less than three times—viz., on April 19, July 10, and on the occasion referred to above.

METEORS.

(*To the Editor of the Times.*)

I see from a letter which appears in your paper of yesterday that a remarkable meteor which was visible in this county on the night of Monday last, the 15th inst., was visible also in the north of England. It would be a matter of some interest to know over what area of country it was seen. It burst about 50 degrees above the horizon in the N.N.W., and its great peculiarity was in the appearance presented by the luminous vapour which was the product of its explosion. This vapour was brighter than the tail of any comet—at first linear in shape—with sharp irregular projections. It was soon, however, curled up, as if by an atmospheric current, into the form of a horseshoe, and in this form seemed to drift very slowly before the N.E. wind in a S.W. direction. It gradually, but very slowly, lost its brilliancy, remaining visible for more than a quarter of an hour.

The brilliancy of the vapour was the more remarkable as the sky was cloudless at the time, and the vapour shone out from the after-glow of sunset which is so strong in these latitudes at this season of the year.

The meteor appeared a few minutes after 9 p.m.

Inverary, Aug. 19. ARGYLL.

A splendid meteor passed over this place on Saturday about 9.25 p.m.

I was walking in my garden, in an easterly direction, when suddenly all objects about me were illuminated, I supposed, for an instant, by a flash of lightning. Glancing overhead, I saw a globe of light, apparently nearly half as broad as the full moon, sailing steadily but rapidly in a direction nearly from west to east, and somewhat north of the zenith. The light, at first a brilliant white, faintly tinged with violet, passed successively to pink, crimson, and at the instant before extinction to a pale green.

A few dull, reddish sparks remained in the neighbourhood of the point of extinction sufficiently long to enable me to place that point very near to a certain bright star which I ascertained afterwards, by means of a celestial globe, to belong to the constellation Cassiopeia (probably Cassiopeiæ).

As to the point of first appearance, I can only guess, from the direction and velocity of the body when I first caught sight of it, and from the time the previous illumination had lasted, that it must have first appeared somewhere about the altitude, and a little to the south, of the last star in the tail of the Great Bear (η Ursæ Majoris).

If any other observer or observers have noted the position of this remarkable meteor, perhaps the above rough notes of its position may (in the absence of more exact observations) be sufficient for obtaining a rough estimate of its altitude.

Linton, Cambridge, Aug. 22. E. W. WILKINSON.

I have seen this evening, about 9.20, a meteor that, in the visible effect of its lustre, surpassed even that "great meteor" which others, as well as I, observed on the 15th of October, 1863, and on which two letters of mine appeared in the *Times*.

In my return home, through a field, close to Combe Church, I was stepping westward, when a sudden blaze, well nigh "a flood of day," far round illumined the country. Looking back (for the splendour came from the east), I saw a ball of white light, which, I should say, was about half the apparent size of the full moon, and which, with a slowness that enhanced its grandeur, dropped perpendicularly from the zenith. It was then about midway to the earth: when it had fallen half the remaining distance it burst, without scattering any sparks. It fell apparently but a field or two behind me. I am curious to see where other observers place the descent of this glorious apparition.

J. HOSKYNS-ABRAHALL.

Combe Vicarage, near Woodstock, Aug. 20.

METEORIC ASTRONOMY, BY PROFESSOR GRANT.

METEORS are divisible into three classes—aerolites, fire-balls, and shooting-stars. 1. An aerolite is a stone which has fallen from the sky to the earth; an occurrence which has been proved in modern times, though long doubted by scientific men. Livy states that in 654 B.C. a number of stones fell from heaven upon the Alban Hill, near Rome; and it is also related that, in 468 B.C., a large stone, equal in size to two millstones, fell at Ægos Potamos, in Thrace. Numerous instances have occurred in modern times. A stone weighing 56 lb. fell at Thoring, in Yorkshire, on December 13, 1795, accompanied by loud explosions resembling heavy guns; and in 1866 a stone fell in Hungary weighing 600 lb. Aerolites consist principally of iron mixed with chromium, nickel, tin, copper, and other elements; but nothing has been found in them which does not exist in terrestrial substances. There are also found, in various parts of the world, large metallic masses, consisting of elements not existing in the rocks of those countries. These masses are presumed to be aerolites, and are termed meteoric iron. The British Museum contains such a mass, weighing 8,000 lb., found in Australia. 2. Fire-balls—large, luminous globes—have been frequently seen traversing the heavens, apparently with great rapidity, and ultimately bursting into fragments with a loud explosion. In 1783 one travelled from Shetland to Rome with a velocity of thirty miles in a second, the velocity of the earth being nineteen miles in a second. Halley conjectured aerolites and meteors to be produced by the agglomeration of materials in the upper regions of the atmosphere; but this notion, as well as that which attributes them to the energy of volcanic agency in the moon, is found to be untenable The theory most accordant with the facts is that of Chladni, who supposed meteors to be cosmical bodies, which, on approaching the earth, are attracted by the force of gravity into the terrestrial atmosphere. 3. Shooting-stars, accompanied by a train of light, and seen on any clear night, are generally visible for little more than a second. Their height, as determined by Brandes and Benzenburg (two German physicists, near the end of the last century), ranges from thirty to seventy miles above the earth's surface, and they travel at the rate of thirty miles a second. The attention of scientific men was first drawn to the celebrated November shower of meteors by that of 1833, when it was found that similar ones had been recorded in 1799, and also in 1766, but not so clearly. The German astronomer Olbers was thus led to conjecture that the apparition might be periodic, recurring in periods of thirty-three years, and that, consequently, another such shower might be expected in 1866. This conjecture, as is well known, was faithfully and brilliantly verified; and in 1864 Professor Newton, of Yale College, United States, collected and discussed all the accounts respecting the November star-shower to be found in historic records, European, Arabian, and Chinese; and hence also determined that the apparition would again occur in the night of November 13, 1866. He further discovered the important fact that the node of the orbit of the meteors had a direct motion upon the plane of the ecliptic—an effect clearly due to the disturbing action of the planets on the meteors; and he also pointed out that, while the phenomena might be accounted for by five different suppositions, as regards the magnitude and form of the orbit in which the shower revolved, a comparison of the observed motion of the node with its motion computed upon each of these different suppositions, would supply an infallible criterion for determining which of the five assumed orbits was the one in which the meteors really revolved. Adopting this view, Professor Adams ascertained that the true orbit of the meteors is a very eccentric ellipse, the time of revolution of the meteoric stream round the sun being thirty-three years and a quarter. It has been conjectured, upon good grounds, that the meteoric stream was originally a mass of nebulous matter, drawn into the solar system by the distinct action of some of the larger planets, in the same manner as Lexell's comet had been thrown into a new orbit and rendered visible by the disturbing action of Jupiter. Le Verrier, in fact, has found that the November meteors were originally introduced into the solar system in 126 A.D., in consequence of having approached very near Uranus. The periodicity of the August meteors was first ascertained by Quetelet, who also pointed out the remarkable relations between the elements of the orbit of the November meteors and those of the first comet of 1866. As a similar resemblance has been ascertained to characterise the orbits of the August meteors and the Hind comet of 1862, it would apper that the comets of 1862 and 1866 were very probably great meteors. In connection with the stream of meteoric matter shown to be revolving round the sun, Professor Grant referred to Le Verrier's researches in physical astronomy, which indicate the existence of two meteoric rings, one revolving at the same mean distance from the sun as the earth, the other revolving within the orbit of Mercury; to the swarm of small planets (revolving between Mars and Jupiter), which probably are merely larger members of a meteoric system; and to the triple ring with which Saturn is encompassed, which there is good reason to believe is composed of a multitude of minute separated bodies. Although, said the Professor, many points respecting comets and meteors are still shrouded in mystery, past experience leads us to hope that the advancing light of science will dispel the existing darkness, and that conclusions of a definite nature will be ultimately arrived at respecting the constitution of those wondrous bodies, and the part which they play in the great scheme of the universe.—*Royal Institution Lecture.*

NEBULÆ AND COMETS.

A NEW theory of Nebulæ and Comets has been communicated to the *Philosophical Magazine* by Mr. Davis, of Leeds. It is contended that there exist in space large masses of matter in a gaseous state which are non-luminous, and therefore invisible. This matter is necessarily very rare, because there is no solid nucleus to condense it by attraction. As long as a mass of such matter remains by itself it continues gaseous, non-luminous, and invisible. It will sometimes happen, however, that two masses of gas having a chemical affinity for one another coalesce under the influence of their mutual gravitations. When this occurs chemical combination will take place with an evolution of light and heat, and a nebula will begin to be formed. Chemical action between the gases will only take place in their bounding surfaces, and the apparent shape of a nebula will not necessarily reveal its real shape or extent, but only the form and extent of the bounding surfaces where combination is going on. The product of the combination may be such that it will only exist as gas at high temperatures. When cooled it may assume the liquid or solid state, and the liquid or solid particles will gravitate towards the centre of the nebula and form a nucleus producing also light and heat as one result of such gravitation. Spiral nebulæ will be produced by the gravitation of the particles towards a centre, just as a spiral motion is produced in a basin of water if allowed to flow out through a hole in the bottom, towards which the water gravitates from all sides. Planetary nebulæ having more than one envelope may also be formed in the manner described, the envelopes being formed in succession in different periods of time. Comets, like nebulæ, are supposed to consist of large masses of gas; and a comet which enters the sun's envelope has a large tail of gas, which is invisible until heated to such a temperature as to favour combination or until lighted by the sun's heat. The tail of a comet spreads because the further it is from the nucleus the less it is condensed by the action of gravity or by the attraction of the nucleus. The sun itself is, on this theory, supposed to be a nebulous star, enveloped by matter extending an immense distance beyond its photosphere; and the zodiacal light, the bands of meteoric matter passed through by the earth, and the retardation experienced by comets are all accounted phenomena showing the existence of such matter.

ECCENTRICITY OF COMETS.

PROFESSOR GRANT, in his fourth lecture, delivered at the Royal Institution, considered the circumstances depending on the generally great Eccentricity of Cometary Orbits, commencing with those comets which approach very near the sun at their passage of the perihelion, amongst which those of 1680 and 1843 were especially prominent. The latter, at the time of the passage of the perihelion, was only about 100,000 miles distant from the sun's surface, and the heat was equal to that which would be transmitted to the earth's surface by 29,000 suns; but this lasted for a short time only. The comet was then travelling at the rate of 1,200,000 miles an hour (about twenty times the orbital velocity of the earth); consequently, it soon escaped from its close proximity to the sun; in fact, during an interval of twenty-four hours its distance from the centre of the sun increased in the proportion of one to ten. Its light, also, when so near the sun, was equally remarkable, and was seen by many persons, in various parts of the world, with the naked eye.

The Professor then commented upon the mutually compensatory effects produced by the comet's velocity and the sun's attractive force; the result being that the path of the comet was curved very much at the perihelion, where the sun's attraction was the greatest possible, but not more than it was curved at the aphelion, where this attraction was least intense. He referred to two conclusions suggested by the observations of the great comets of 1680 and 1843:—1. That the nucleus of a comet must be, in some instances, a solid body, since otherwise it is impossible to conceive that a mass of nebulous matter can escape utter dissipation in space by reason of the intense heat to which it is subjected at the passage of its perihelion. 2. In reference to a recent theory of the physical constitution of the sun—that solar heat may be due to the frictional effect produced by a zone of meteors encompassing the sun and circulating round it. If this be true, he said, the resistance offered by such a zone ought to have produced a sensible effect upon the comets of 1680 and 1843; whereas, not the slightest derangement in their movements attributable to such a cause was indicated by the observations. The near approach of comets to the earth was next considered; and it was stated that in some cases the orbit of a comet intersects the plane of the ecliptic in two opposite points, almost coinciding with the terrestrial orbit, which, in respect to Biela's comet, created so much alarm in 1832 from the supposed possibility of collision with the earth. Actual investigation demonstrated the groundlessness of this alarm; still, the movements of comets are so eccentric that such a collision must not be regarded as impossible, although such a contingency is very remote, and, even should it occur, would be probably without any disastrous consequences, since the cometary masses are believed to be very small. The near approach of comets to any other planet was next considered, and illustrated by reference to Jupiter, the most powerful disturber of their movements. Lexell's comet (invisible previous to 1770), having approached very near Jupiter, in 1767, was by the attraction thrown into a new orbit and rendered visible, and by another approach, in 1779, was a second time thrown into a new orbit and made invisible. Reference was then made to Encke's comet, which, by its approach to Mercury, enabled astronomers to determine the mass of that planet. Encke's theory of the existence of an extremely rare medium pervading space and offering resistance to the movements of the celestial bodies, based upon his observations of this comet, was referred to by the Professor, and considered to be supported by no other evidence; and the lecture was concluded with remarks on the probable number of comets which visit the solar system.

REMARKABLE COMETS.

PROF. GRANT, in his fifth lecture, delivered at the Royal Institution, after reminding his audience that in his previous lectures he had shown that comets are bodies revolving in the celestial regions, and governed in their movements by the same great law of attraction which retains the planets in their orbits, said that he proposed now to consider the natural questions, what is the constitution of those wondrous bodies?—and what is the purpose which they serve in the great scheme of the physical universe? In order to do this, he thought it desirable to present a view of the more striking physical phenomena by which they are characterised. Little can be deduced from the earlier recorded crude observations of Europeans; but the descriptions of Chinese writers have thrown most valuable light on many points of cometary astronomy. The comet of 1378, one of the earliest of these typical comets, was proved by M. Edouard Biot to be identical with Halley's comet. In 1402 appeared one of the grandest comets mentioned in history. It continued visible for eight days, even in full sunshine, and all writers concurred in representing it as a terrible phenomenon. It was one of the few comets visible in daylight. In 1456 consternation was occasioned throughout Europe by a great comet which, from its apparition shortly after the capture of Constantinople by the Turks, was, together with them, anathematised in a bull issued by Pope Calixus III. This comet, conjectured by Halley to be identical with the one which bears his name, was decisively proved to be so by Pingré, the French astronomer. The comet of 1531 is memorable from its having led the German astronomer Apian to conclude that the tails of comets extend in the direction opposite to the sun. The seventeenth century was illustrated by some of the greatest comets of modern times. That of 1618 was especially memorable. Father Marsilius assured Kepler that he saw it with the naked eye in full daylight. According to Longomontanus, the tail was 104 degrees in length, and exhibited enormous vibrations, and Cysatus, a Swiss astronomer, observed symptoms of its breaking up into several parts, a phenomenon not unsupported in history. Seneca refers to a comet mentioned by Ephorus, a Greek writer, which divided into two parts before disappearing; and Biela's comet in our own day furnished another example. The comet of 1680 was distinguished for its near approach to the sun at the time of its perihelion passage, and for having enabled Newton to demonstrate the subjection of comets to the same laws as the planets in their orbits. The comet of 1729, which of all the comets whose orbits have been calculated has the greatest perihelion distance, supplied the groundwork of some speculations on the probable number of comets which visit the solar system. The comet of 1744, the most splendid of the century, was visible in daylight, and, according to Chésaux, a Swiss astronomer, was accompanied by a fanlike tail. The great comet of 1769 illustrated the growth of the tail as it approached the sun. The passage of the perihelion occurred on October 8. On August 15, the tail measured 6 degrees; on the 28th, 15 degrees; on September 2, 36 degrees; on September 10, 60 degrees; on November 30 (after the passage of the perihelion), only 1½ degree. After a detailed account of the comet of 1811, the most remarkable in modern times, the Professor concluded with a description of the singular physical changes perceived in the heads of the comets of 1835, 1858, and 1861, as they approached their respective perihelia. Professor Grant, in regard to the formation of the tails of comets, stated that, although innumerable theories had been propounded, no satisfactory explanation had yet been given; and after a brief notice of the earlier opinions of Kepler, Newton, and Prevôt, he described the recent ingenious theory of Professor Tyndall founded upon the active influence which light exercises upon vapours existing under certain conditions. This theory, although, like the others, incapable of supplying a complete explanation of the observed facts, is valuable as being founded upon a principle established by experimental research, and in harmony with two of the most striking phenomena of cometary physics—viz., the rapid extension of the tail of a comet about the time of the passage of the perihelion, and the extreme tenuity of the material substance of which comets are composed. The question whether comets are self-luminous, or whether they are indebted wholly to the sun for their light, has been much discussed; and the Professor said that, although the light of comets is in all probability due in some degree to the reflection of the sun's rays, still there has been not unfrequently observed, during a comet's descent to the perihelion, intermittent variations of brightness, which cannot be explained by the varying distance of the comet from the earth and sun, as would necessarily result if the comet shone solely by reflection. The result of Mr. Huggins's spectroscopic observations of Brorsen's comet and Winnecke's comet, both of which returned to the perihelia of their orbits in 1869, seem to indicate that comets are gaseous bodies composed mainly of carbon. The Professor concluded with a brief exposition of the opinions entertained by Newton and other astronomers with respect to the purpose which comets appear to serve in the great scheme of the physical universe.

D'ARREST'S COMET OF SHORT PERIOD.

Mr. Hind writes to the *Times* on September 27: On each of the last four evenings we have succeeded in obtaining observations of D'Arrest's Comet of Short Period (first recognised in 1851), though it is an object of extreme faintness, and could be steadily seen only in a first-class telescope.

"Knowing that it had been sought unsuccessfully with powerful instruments at several foreign observatories, and only once suspected to be 'glimpsed' by Dr. Winnecke, at Carlsruhe, we had but small expectation of detecting it here. The evenings lately, however, have been unusually favourable for astronomical purposes, and I have had proof on similar occasions during the last 25 years that Mr. Bishop's object glass, worked by Mr. Dollond, is one of first-class excellence, and as nearly as possible perfect in its performance for its aperture.

"For the sake of brevity I give the results of one only of the four evenings' observations which we consider the best, viz.:—September 25, 7 h. 32 m. 23 s. mean time at Twickenham; Right Ascension, 17 h. 58 m. 50·02 s.; Polar Distance, 111 degrees 15 m. 17·6 sec.

"The mean correction to the ephemeris by M. Leveau, of the Observatory at Paris, is — 24·49 s. in R.A., and—1 m. 39 s. in N.P.D.

"The comet discovered at Marseilles on August 28 by M. Coggia will be visible for some time; at present it may be seen with very ordinary telescopes. At midnight on September 28 it will be situate in R.A. 0 h. 33 m., and P.D. 64 degrees 10 m.; and on October 3 in R.A. 23 h. 56 m., and P.D. 61 degrees 49 m. Its orbit does not resemble that of any comet previously computed; indeed, I have ascertained, from our observations to September 19, that its path in the heavens is exactly represented on the assumption of motion in a parabola.

"The Aurora Borealis of Saturday, described by correspondents in your impression of this morning, was well seen here, as also was the more notable one of May 20, of which I did not meet with any account from the south of England."

Mr. John Lloyd writes to the *Times*, from Hereford: "On the morning of October 19th, I rode in the midst of blinding wind and rain to see some men that were working near a wood at Llanwrtyd, Breconshire. I found that the men had been driven to seek shelter from the rain, and I was induced by them to shelter also for a few minutes before entering the wood.

"While we were thus standing together a sudden irresistible blast passed up the valley, and almost simultaneously 11 oak trees fell to the ground before us, uprooted. There was no swaying of the branches, but the trees fell just as bare poles would fall. The noise of the storm, hitherto raging, seemed hushed for a moment, and a low whistling sound was all that I heard. The time was as nearly as possible a quarter before 11, and the trees all fell within 3 seconds, and alike in the same direction, west to east.

"Llanwrtyd is about 80 or 90 miles due west of Stratford-on-Avon, and the storm thus described was probably that which reached Shakespeare's birthplace an hour later."

Another Correspondent, "T. K. T.," describes the above Tornado as "passing over, or rather through, Westbury, near Wells, Somerset, about half-past 11 A.M., doing considerable damage. Its force was confined to a space of about 100 yards wide; its direction was from the west. The air, for about a minute, was filled with earth, leaves, &c.; many trees were blown down, some stripped of leaves and branches; the roofs of several buildings destroyed, ricks half blown away; two galvanised-iron sheep-troughs, 12 ft. long, in a field in front of my house, were first turned upside down, and the wind then catching them up, one was deposited safely on my lawn, having cleared a sunk fence wall 4 ft. high; the other, not so fortunate, caught an angle, and was doubled round it like a strip of linen or paper, where it stuck. The cast-iron wheels were snapped off, one being found in the yard attached to the house, and to get there it must either have passed over a gate which was not in its direct course, or over a wall 9 ft. high, which was. The course of the wind was towards Chewton Mendip, where it is said to have done damage; but the chief injury in this neighbourhood was in this village, but only through a space of about the width mentioned."

MIRAGE IN THE FIRTH OF FORTH.

WE have frequently had occasion to report cases of Mirage occurring in the Firth of Forth, but the most extraordinary instance which can be remembered occurred on Friday afternoon, July 22nd. The day was very hot and sultry, and there was a peculiarity about the atmosphere which is seldom observed in this country. About midday a thin, clear, and transparent kind of vapour, through which the surrounding objects began to make their appearance in the most fantastic and grotesque shapes imaginable, settled over the sea. The phantasmagoria were principally confined to the mouth of the firth; but at one time they embraced the whole of the Fife coast as far as the eye could reach, town, village, and hamlet being depicted high up on the horizon with remarkable distinctness. Though the whole coast seemed at least half-way up the horizon, the appearances presented by the towns were very different, some of them having the houses inverted, while others appeared in the natural position. The Bass Rock, the Isle of May, and the rocks around Dunbar harbour, however, attracted most attention, both from their proximity and from the extraordinary forms which they assumed. The Bass, which at one time seemed to lie flat upon the sea, suddenly shot up into a tall spiral column, apparently 10 times its usual height, surrounded by battlements rising tier on tier, and presenting a most imposing spectacle. As usual, however, the most fantastic appearances were presented by the May, which, in the course of the afternoon, underwent an almost innumerable series of phantasmagoric transformations. At one time it was apparently as round as a circle, at another seemingly drawn out for miles against the horizon; now flat upon the water, then rising to 10 times its usual height; occasionally portions appeared to break off and sail away, then to return and unite again—all within the space of a few minutes. Vessels in the offing appeared double—one on the water, and another inverted in the air; and in one instance three figures of one vessel were distinctly visible—one inverted, another on the sea, and a third in its natural position between the two. The fishing-boats proceeding to sea in the evening underwent the same transformations when only a few yards off the shore, the double appearance being distinctly visible within a certain distance. The rocks at the harbour also seemed to play fantastic tricks, opening and shutting, rising and falling, with apparent regularity. These extraordinary illusions lasted from midday till nightfall, and excited great interest among the inhabitants of Dunbar, numbers of whom collected in the Castle Park, and at the harbour, for the purpose of witnessing the phenomena.—*Scotsman.*

WATERSPOUTS IN THE CHANNEL.

MR. C. ALLEN writes from Calais to the *Times*, August 21st, 1870: "On the evening of the 20th inst., between 6 and 7 o'clock, a singular phenomenon was witnessed by a large number of persons at Calais. From the edge of a thick black thunder-cloud two funnel-shaped projections were seen to depend, until they gradually reached the surface of the sea, on which they created a great disturbance, masses of foam rising up to a considerable height around the foot of each waterspout. It was calculated that the long streamers hanging down from the cloud to the sea were nearly a mile in length. The wind caused them to wave about gently, and alter their form slightly from time to time. One of the waterspouts lasted about 10 minutes, and the other about a quarter of an hour. During this time they moved rapidly along the sea, and would probably have proved fatal to any vessel they might have crossed. A bright blue sky below the cloud formed a background, which threw up the long, dark, thin columns with startling clearness. Lightning and thunder followed the termination of this phenomenon, but only a few drops of rain. I have seen several waterspouts in the Pacific Ocean, but never any that could be at all compared with these for great height and wonderful clearness of outline. As might be expected, some of the crowd considered this a portent of the war."

INTENSE COLD.

M. Foselli has announced to the French Academy of Sciences that he has succeeded in producing an amount of Cold just below the zero of the Fahrenheit scale by simple mechanical action creating rapid evaporation. He employs a wheel formed of a spiral tube, both ends of which are open, set vertically and half immersed in the fluid to be cooled, so that the latter passes constantly through the whole length of the tube, half of which is constantly above the liquid, and being wet gives rise to active evaporation and consequent refrigeration within it. The evaporation is increased by a small fan. The principle is well known, but the multiplication of the points of evaporation by mechanical arrangement is ingenious; and in hot dry weather even a disc of iron turning rapidly in liquid would produce refrigeration.

METEOROLOGY IN ITALY.

Professor Zantedeschi has published his fourth yearly Report on Temperature in Italy, showing the hourly, daily, monthly, and annual oscillations of heat for 1867. He takes notice also of meteors, hurricanes, thunderstorms, and earthquakes, and indicates their connexion with atmospheric electricity, with disturbances of the magnet, and with astronomical phenomena. The learned Professor believes that the movements of the declinometer may be used after the manner of a clock, to show the daily rotation and annual and secular revolutions of the earth, and of the solar system round other central systems. And he regards the currents of atmospheric electricity in their action on the magnet as a better indicator of the approach of bad weather and storms than the barometer; and cites cases in point. Although this Report contains much that is speculative, it serves to show one of the tendencies of natural science. A theorist works with spirit, and makes mistakes, until nature sets him right with her stubborn facts. Professor Zantedeschi has done much good work for science, and being an active investigator, may be expected to do yet more.—*Athenæum.*

THE AURORA BOREALIS.

Seldom in these latitudes have we had opportunities of witnessing the mysterious lights with such brilliancy and frequency as during the past year. In February, April, and September there were displays above the average in splendour; but never during the past twenty years has there been such a sight in these middle latitudes as was presented by the sky of October 24. In the evening, about 7·30, the sky over London was overcast with a bright appearance similar to what is often seen in connexion with a great conflagration. In a short time several forked pillars of the Aurora made their appearance, extending from the zenith in a north-western direction. The pillars were of considerable brightness, and after flitting and moving about in the atmosphere for some time, they entirely disappeared. There was scarcely any wind, and the atmosphere, although not decidedly frosty, felt keen. At a few minutes past eight o'clock, the " calls" were received simultaneously to a large fire supposed to be raging in the locality of Kingsland. At that moment a bright cloud could be witnessed in the northern and western horizon—the points, as far as they could be traced in smoky London, were from the east-north-east, terminating, as near as possible, west north-west by south. From all parts of this cloud issued flashes, first of dark red, changing to light blue, and succeeded by others of an orange pink and even green hue. The whole rose in pulses along the dome of the sky towards the zenith, where the corona was about to form, when it suddenly parted. It was not till then that the many thousands of London fire-seekers became convinced that they had been deceived as to the raging of a fire. The London Salvage Corps turned out with their engine and traps, and the metropolitan bridges were crowded with thousands of persons, watching what they imagined to be the progress of the largest fire that had ever occurred in London. The moment the phenomenon disappeared the stars shone out brilliantly, with a clear blue sky.

At eight o'clock the sky north-east of Windsor Castle was most brilliantly illuminated by the Northern Lights. So bright were the atmospheric phenomena that crowds of people rushed up to the Castle under the impression that a large fire was raging in the district. The Aurora consisted of various tints, chiefly of a rose colour, variegated with streaks of yellow and white light, fading into cerulean blue with a tinge of green. The display lasted about an hour. The dark outline of the Castle Chapel stood out wonderfully against the strange bright light.

At Norwich a magnificent display of the Aurora was visible about ten minutes past eight, and lasted about twenty minutes. The whole horizon was lit up with masses of colour, as if the town were on fire. The streamers were white, suddenly changing to pink, and then to carmine, while the corona in the zenith was deep purple. These gave place to other white streamers, again colouring. A less vivid display was visible for some time longer.

From Henry Wright, Thuxton Rectory, Norfolk:—

" About a quarter-past eight o'clock splendid streams of auroral light illuminated a vast extent of the heavens, reaching from Aldeboran in the east to beyond Atair in the west. Of these streamers two were the most remarkable, one emanating from the east, a few degrees above the horizon, the other from the west in a similar manner.

The auroral band in the east, bounded on the one side by Aldeboran and on the other by Capella, spread in a fan-like shape over the constellations Perseus, Andromeda, and Cassiopeæ, to a star in the head of Cepheus; while the western streamer, spreading in a similar manner over the constellations Aquila, Sagitta, Lyra, and Cygnus, reached also its culminating point at the above-named star in Cepheus, which thus formed at the zenith the point of junction between the two streamers.

The colour of these arches was of a splendid deep blood-red, giving to the heavens the appearance of a large conflagration.

When the *lumen boreale* was at its height I noticed through the streamers a falling star in the constellation Auriga, thus showing that the auroral phenomenon must have been very near to our planet, as the shooting stars are generally supposed to prevail at an altitude of about sixty miles above the earth.

The planet Jupiter and the Pleiades were plainly seen through the crimson canopy, presenting a singular and beautiful appearance.

The cause of the auroral displays is supposed to be more or less owing to magnetic influences, and it is a singular circumstance that when the spots on the sun are at a *maximum* (as is the case at the present time) then the Auroral Lights are more frequent and more brilliant.

From W. Morgan Campion, Queen's College, Cambridge:—

"The Aurora itself was of an unusual character, seeming to radiate from a point nearly in the zenith, though the radiation was by no means uniform. A broad band of light of a beautiful rose colour extended across the heavens nearly in the prime vertical. At the moment of its greatest splendour (6·4 p.m.) there appeared a large luminous body, which, starting from the radiant point, travelled with great velocity nearly in the plane of the meridian, leaving behind a brilliant track of light, which was caused, at least partly, by the actual wasting of the nucleus. When it first became visible the apparent diameter was, as nearly as I could judge, 15 degrees; it rapidly dwindled, however, and finally vanished in the constellation Ursa Major, having occupied about three seconds in its transit."

Mr. E. J. Lowe, of Highfield Observatory, near Nottingham, gives the following singular features:—

The brilliancy and intense redness of the colour on the 24th inst. were so remarkable that it is twenty-two years since any approach to this grandeur has been seen, and, strange to say, in 1848 the great display of Aurora Borealis was also on October 24.

The Stanton Iron Works cast a strong glare here, but during the time of the greatest brilliancy of the Northern Lights the glare was invisible. Only the larger stars were visible through the Aurora, and these were red in colour.

The cupola was well formed, having curtains in all directions. Although not so brilliant on the 25th inst., the phenomenon was even more singular. Before sunset a yellow haze was observable along the south horizon, and from 6 till after 7 p.m. the coloured light above the south horizon was most intense, resembling that usually seen in the north, but without coruscations; several pink curtains hung above, but were unconnected with this light. At the same time a similar mass of light was also seen along the north horizon, from which issued streams of aurora. There were also intense luminous masses in E. and W. of a red colour, though that above the south horizon was much the brightest.

That portion to which I more particularly wish to call attention is the cupola, the changeable character of which was the most interesting portion of the phenomenon.

On the 24th inst., at 8.5, red rays passed across each other in all directions, so as to extend beyond the point of convergence, while a wavy riband of opaque white light extended through the cupola.

On the 25th, at 6.32 p.m., rays converged from all points of the compass between W. and E. (through the N.), which became mingled together on the southern half, forming an appearance not unlike the nebula of Orion when seen telescopically.

At 6.35 the rays did not quite reach the converging point, but upon it was the appearance of a white cross.

At 6.54 the rays became curved near this point, leaving an open circular space, in the centre of which a small star shone brightly.

At 8.30 the appearance was that of a letter M.

The central point was not stationary, but oscillated in a given space.

At 9.15, instead of a single low arch spanning the horizon from W. to E., there were two; one extending from W. to N.N.E., and a second crossing it, and reaching from N. to N.E. Coruscations extended into the zenith from both these arches.

There were many falling stars during the continuance of the Aurora Borealis.

These displays were followed on the 27th inst. by two thunder-storms, one passing from N. to E. at 3.30 p.m., and a second from W. to S. at 5 p.m. The lightning was all horizontal (from cloud to cloud) and more extraordinary than I have ever witnessed, being bicoloured—the basal portion as white as snow and having a narrow upper belt of intense blue. This was apparent, both when looking at the flash itself and when seeing it by reflection on a sheet of paper. So intense was the white colour that ordinary writing paper looked dark by comparison when the flashes were reflected upon it.

To-day (28th inst.), at 6 p.m., there was lightning in the N.W.; and at 6.30 p.m., while very dark, and rain falling heavily, three separate times a spark-like light exhibited itself momentarily (between S. and S.E. at altitudes of 30 deg. to 40 deg.), not unlike a small meteor, yet appearing and vanishing without any sensible change in position.

The electrical phenomena of the 27th and 28th are to me quite new, and, in short, at the present time we are experiencing a remarkable meteorological epoch.

Mr. T. H. Morgan, Strass, Lago di Maggiore, describes the phenomena of October 24, at past 9 (Italian time):—

The lake was of a blood-red colour, and no wonder. From W. by N. to N.E. by E. the sky was a brilliant rose, a circle of about 140 degrees of pulsating flames, varying in height from 40 to 60 degrees, the portion from N. by E. to N.E. by E. being exceptionally bright; the next brightest portion being that to the extreme western end. At 9.20 it was at its most brilliant period. In another five minutes the inner portion of the vast arc had become faint, when in an instant there shot out in all directions bright steel-coloured streamers, many of which reached the zenith. Those that passed through the still brilliant rose-coloured terminations of the circle had an indescribable beauty, while those that shot forth from the N. to N.W., with a background of cold bluish green, frequently changed colour from steel to rose. These conditions continued with fluctuations for another quarter of an hour, with one apparent effort to re-rose the whole circle. Afterwards the N.E. end began to drift eastwards, paling as it went; but it remained long after the rest had expired, a column of pale rose light, which at 9.50 almost impinged upon Jupiter. The streamers (of course it was illusion) seemed quite parallel.

The sky was intensely clear; air cold, with constant flashes of lightning over the eastern horizon.

No one here remembers so brilliant a phenomenon of such extensive dimensions, a remarkable one in 1848 having been only one-third as extensive.

From W. F. Denning and C. R. Gardiner, Bristol:—

Another very remarkable display of the Aurora Borealis occurred last evening, October 25, soon after sunset. The phenomenon was noticed at 5.50, when several streamers were visible to the west of the constellation Auriga. In the neighbourhood of these streamers a cloud of crimson light rapidly formed, which alternately decreased and increased in brilliancy. It extended from the north-east horizon to Aquila, and even to situations further south. The crimson colour was particularly intense near the zenith. At 6.10 there appeared to be numerous streamers diverging from a radiant point in this portion of the sky. The majority of the rays were inclined towards the south and west, but many were seen in other directions. At 6.25 the sky in the north-east became partially overcast with dense clouds, which to a great extent obscured the phenomenon. At 6.28 a mass of crimson light appeared in the north-west, and numerous streamers were perceptible in all parts of the sky. At 6.32 sixteen well-defined auroral rays were noticed between the northern and western parts of the sky. At 6.35 all the streamers had disappeared, and the clouds of light in the north-east and north-west had become much less intense. The streamers re-appeared at 6.42, and in all parts of the sky the auroral light was much stronger. At this time the crimson hue was more intense between the constellations Auriga and Cassiopeæ. A well-defined streamer of considerable magnitude was visible at 6.46, passing through Perseus and Cassiopeæ. After this time the aurora was comparatively insignificant. Several streamers were visible, and an unusual glow in the north was apparent at a much later hour, but it was evident that no great revival of the phenomenon was probable. It may be remarked that this display, like the one observed on October 24, became visible immediately after a shower of rain.

From "G. H. H.":—

Here, on the borders of Essex and Suffolk, yesterday evening, October 24, at 8 o'clock, was seen a most magnificent Aurora Borealis. I never in my life saw anything to equal it. From the Pole star eastwards to beyond Capella, nearly as high as Cassiopeæ and almost as low as the horizon was one blaze of rosy light, behind which every star was visible, and to the same distance westward of the Pole star was the same light, but not quite so bright, and between these two divisions were the usual silvery horns or rays darting high into the heavens. The rose tint of the fiery light was most unusual, and reminded me of the glorious colour of the wings of a mass of Indian flamingoes. The effect for about a quarter of an hour was sublime.

There was a magnificent display of the Aurora on the north-east coast of England on Tuesday night, October 25, the most remarkable and beautiful that has been observed by the present generation. From 6 to half-past 7 o'clock the horizon from east to west was spanned by a broad zone of rich crimson colours, presenting the appearance of a reflection of a great fire. At one time there was a great dome, out of which radiated beautiful prismatic colours. There was also visible at intervals long lines of white and yellow light, fading into a cerulean blue, with a tinge of green.

From "E. D. B.," Clarencefield, by Annan, N.B.:—

Yesterday evening, October 25, an Aurora of the greatest conceivable magnificence was visible here from about 6.30 p.m. until mid-night. The pillars of light extended, as appears to have been the case in the metropolis on the preceding evening, from a point just south of the zenith to the horizon in all directions—as a bystander remarked, like an umbrella,—but were brightest in the east. They were of the most brilliant colours, sometimes white, then changing to pink, deep crimson, purple, green, and yellow. The atmosphere was cold, but there was very little wind, a slight breeze only blowing from the westward. The night was star-light, and, excepting the Aurora, the only prominent feature in the heavens was a dense black mass of cloud away down to the southern horizon, slowly crossing the sky from west to east. These clouds were such as precede a heavy thunderstorm, but although there was a little lightning, no thunder was audible; they were for some time lighted up by the intense crimson of the Aurora, and filled up the measure of one of the most beautiful sights it was ever my lot to witness. Several Auroras have been visible here during the last ten days, but they were all very faint, and none of them could for a moment be compared to that of the above evening in brilliancy. The night, which, it may be added, was otherwise a dark one, was for several hours rendered as light by the Aurora as by a full moon; but it is curious that the phenomenen should have occurred here 24 hours later than in London.

THE TELEGRAPH AND THE AURORA.

MR. R. S. CUTLEY, Engineer of Telegraphy to the Postmaster-General, in a letter to the *Times*, says:—The same cause which produces the Aurora produces also currents which flow from one part of the earth's surface to another, and, as a telegraphic wire is always connected to the earth at each end, a portion of these currents must necessarily pass through the wire from one station to the other, provided the two stations happen to lie in their course, which is usually, though not always, nearly east and west.

These so-called "earth currents" are frequently very powerful (they were especially so, as might have been expected, during the late brilliant displays), but what is more troublesome still, they constantly vary in strength, and also in direction, and consequently make it impossible to read a message.

They also affect the mariner's compass, but not sufficiently to be visible, except under special arrangements. They were powerful enough, however, on Tuesday evening (Oct. 25) to deflect the magnet of a Thomson's galvanometer, which is really a compass needle very delicately suspended, as much as 200 divisions when it was not connected to any wire whatever.

It will be obvious from what has been said that some telegraph wires are more disturbed than others. Those running nearly east and west suffer most. It will also be readily seen that if the connexion with the earth can be dispensed with the currents will not enter the wires.

When there are several wires available between two stations, the earth connexions are cut and the wires are looped, so as to use one of each pair as a return wire in place of the earth, thus forming a complete metallic circuit. But, although this plan is effective, it will be seen that it enables us to use only one-half of the instruments affected. At the central-office on Tuesday we were obliged to loop fifty wires in this manner, losing at once 25 circuits.

We can also connect two wires so as to throw the terminal stations out of the line of disturbance, but, as the direction of the earth current is seldom constant, this method does not give very good results.

It is also possible in some cases to divide the wire at both ends, introducing a condenser, or very large Leyden jar, and signalling by inductive discharges. This answers perfectly for a cable, but has not at present been found effective for land wires.

It has been said that the "Northern Lights" have only recently affected the instruments to any serious extent, and this because insulation is not now as well attended to as some years since. Permit me to say that this is a misconception; the effect of the earth current is in many cases the greatest, in the best insulated line. The Atlantic cables, whose insulation is absolutely perfect, are more disturbed than any land line, and are always worked either by the loop or the Leyden jar arrangement.

"A Telegraphist," after describing the phenomena of the Aurora of Oct. 25, as he witnessed them from Hyde Park, London, adds: — I had heard that these phenomena were usually preceded by so-called "earth-currents," but I also understood that the interruptions were chiefly upon lines running east and west; yet we read that the lines running north to Scotland were interrupted.

If these interruptions to the telegraph are really earth currents, could they not be obviated, where there is a double line to the same stations, by cutting out one instrument and using its wire as a return wire to the other one, instead of an earth current, thus sacrificing half the power for a perfect circuit? Should this plan not succeed, is it not possible that the appellation of "earth-current" is erroneous, and that "atmospheric current" would be more correct?

MOCK SUNS.

Mr. G. P. Bidder, in a letter to the *Times*, describes the following phenomena which he and some friends witnessed at Canterbury on the afternoon of October 7:—At about 4 p.m. the sun, which was then in a light watery cloud, was observed to be surrounded by a halo upon which were visible three parhelia, or mock suns, in the usual positions; that to the left was exceedingly brilliant, apparently almost equalling the sun in brightness; the other two were faint and ill-defined.

These continued visible for several minutes, and then gradually disappeared; but the halo was still distinct. Then was observed an appearance which I have never before seen, nor remember to have met with, in any description of meteorological phenomena.

A portion of a circular arc was seen considerably above the halo, and convex to it and the sun. The centre of the circle, ot which it formed part, was, as nearly as I could estimate, close to the zenith. This arc was not of the pale sickly colour usual to a halo, but had all the prismatic colours pure and distinct, and was in all respects similar in appearance to a rainbow. The portion visible was about 80 deg. or 90 deg.

The following rough approximations represent the general arrangement of the whole:—Altitude of the sun, about 12 deg. radius of the halo about 25 deg.; interval between the nearest points of halo and rainbow arc, about 25 deg.; radius of rainbow arc, about 25 deg. I have, I think, seen drawings of parhelia, showing small luminous arcs convex to the sun, touching the halo at the points where the mock suns appear; but this rainbow arc was very different, being separated from the halo, as the above figures show, by a very considerable interval. I should be glad to learn if it had been previously observed."

ECLIPSE OF THE SUN.

We quote the following from the *Times'* reports: The Eclipse of the Sun was distinctly seen in London on Dec. 22, 1870. Owing to the cloudy state of the atmosphere the sun was not at first visible; but at a quarter-past 12 the sky became very clear, and after this time the progress of the phenomenon could be distinctly watched to the end.

The eclipse was seen to great advantage from the streets of Manchester. A clear frosty atmosphere prevailed, and at about one-third of the obscuration the sun shone out brilliantly, but during the greater part of the eclipse it could be with ease seen by the naked eye. At the moment of greatest obscuration there was no apparent difference in the light, so that, but for the groups collected in the streets to watch it, the attention of many people would not have been attracted. A rather thick mist succeeded the phenomenon, and prevailed during the rest of the day.

The eclipse was seen to great advantage at Leeds; the weather being splendid and the view remarkably clear.

The following is a report by Professor Piazzi Smith, Astronomer Royal for Scotland, in reference to the eclipse, as witnessed at Edinburgh:—

"Royal Observatory, Edinburgh, December 22nd, 1870.—The weather was very unfavourable here for observing the solar eclipse of this day, clouds and occasionally falling snow preventing anything being seen at either the beginning, middle, or end of the eclipse. Some temporary glimpses were caught at about 12 o'clock and half-past 12, showing the phenomenon in progress very much as indicated by the nautical almanac, and the sun's disc seemed to be marked with many fine spots, but nothing was seen either long enough or clearly enough for any scientific observation to be made."

At Wick the eclipse was clearly seen at half-past 12.

Mr. Hind writes from Mr. Bishop's Observatory, Twickenham, December 22nd: "The eclipse has been very satisfactorily observed here, so far as regards the times of beginning and ending, with the following results:

	H.	M.	S.	
Began at	11	6	28·9	Mean times at Twickenham.
Ended at	1	40	32·7	

To obtain Greenwich times 1m. 13·1s. must be added to the above. Nothing in any way unusual was remarked during the progress of the phenomenon. A group of spots appeared near the preceding limb of the sun, on an angle of about 267 degrees.

"For Agosta, near Cape St. Croce, in Sicily, to which place allusion is made as a station for observation of the total eclipse, in your impression of this morning, I find the time of commencement is, by a calculation from our best tables, 2h. 1m. 51·8s. P.M., local time, and the duration of total eclipse 1m. 49s. This place would be situate about 3 miles from the line of central eclipse."

Mr. J. G. Symons contributes the following:—

"THERMOMETRICAL OBSERVATIONS AT CAMDEN SQUARE, LONDON, DURING PARTIAL SOLAR ECLIPSE.

Dec. 22	Temp. in Shade	Temp. in Sun	Difference	Amount of Cloud 0—10	Weather
11 0 A.M.	26·2	31·9	+ 5’7	6	Steady snow
11 15	26·4	32·2	+ 5·8	9	Heavier snow
11 30	26·3	30·4	+ 4·1	7	Less snow
11 45	26·2	29·1	+ 2·9	9	Heavy snow
Noon	26·1	28·8	+ 2·7	7	Snow over, clear except in S.
0 15 P.M.	26·1	27·5	+ 2·4	5	Clouds rolled away to N.W., bright sun
0 30	25·8	26·8	+ 1·0	6	Sun dazzlingly bright
0 45	25·8	33·0	+ 7·2	3	Sun dazzlingly bright
1 0	25·4	35·3	+10·4	4	Clouds passing over the sun
1 15	26·3	35·5	+ 9·2	6	Clouds passing over the sun
1 30	26·8	40·2	+13·4	4	Clouds passing over the sun
1 45	27·2	40·3	+13·6	3	Clouds passing over the sun
2 0	27·2	41·4	+14·2	4	Clouds passing over the sun

"1. I suppose almost everyone knows that the temperature of the air is usually lowest shortly before sunrise, and increases steadily until between 1 and 2 P.M. Reference to the column headed 'Temperature in Shade' will show that from 11 15 A.M. to 1 P.M. the temperature fell instead of rose, and this, although the snow had ceased and the partially eclipsed sun shone forth with extreme brilliancy.

"2. It will be noticed that the lowest shade temperature was at 1 P.M., or 35 minutes after conjunction. I observed the annular eclipse of March, 1858, on the central line, and I find that then the lowest temperature was 25 minutes after conjunction. The partial eclipse of July, 1860, gives a somewhat similar result. Hence it would seem that the air is coldest at about half an hour after the greatest obscuration.

"3. The column headed 'Temperature in Sun' contains the reading of a thermometer of which the bulb and part of the stem are rendered a dull black, and which is wholly enclosed in a glass jacket whence the air has been exhausted. This thermometer has been aptly described as a 'heat trap,' and is at present generally employed as a measurer of the intensity of the sun's rays. Reference to the table will show that at 11 A.M., in spite of cloud and snow, this thermometer exceeded that in the shade by nearly 6 degrees. As the sun rose towards its meridian altitude the snow ceased, and the clouds rolled away to the north-west. This difference, under ordinary circumstances, would have increased to at least 20 degrees; but instead of that, it decreased to a single degree at the time of greatest obscuration. As the eclipse passed off it steadily increased, until, at 2 P.M., it was about its normal value for that epoch—viz., 14 degrees. Hence the temperature in the sun appears to have been depressed about 19 degrees.

"4. It is worthy of remark that the temperature in the sun was lowest at 0 30 P.M., or within five minutes of the time of conjunction and half an hour before the air temperature reached its lowest point. In 1858 this interval was 20 minutes, and in 1860 about 10 minutes.

"I think the above goes far towards proving that with a mid-winter London atmosphere, and an unusually cold snowstorm, it is still practicable to trace distinctly the thermal effects of a partial (0·8 degree) solar eclipse. G. J. SYMONS.

"62, Camden Square, N.W., December 22.

"P. S.—Since finishing the above I have received from Mr. Leighton Kesteven a copy of his observations at Holloway, which exactly agree with my own. The following are the salient points:—Difference between sun and shade at 11 A.M., 3·0 degrees; at 11 15, 4·6 degrees; decreasing to 1 degree at 0 20 P.M., and remaining thereat till 0 35 P.M., increasing to 28·5 degrees (much higher than mine) at 1 15 P.M. Lowest temperature in shade 26 degrees, at 0 50 P.M.; lowest in sun 27·8 degrees, at 0 20 and ·25 P.M. Interval between sun and shade *minimum* 30 minutes; just the same as here."

TOTAL ECLIPSE OF THE SUN AT GIBRALTAR.

THE following account is from Mr. R. M. Marioni, F.R.S., dated Gibraltar, December 23, 1870.—"The party that left England for the purpose of observing the Total Eclipse of the Sun at Gibraltar—namely, Messrs. Carpmael, Gordon, Lewis, Buckingham, Beasley, Harrison, Anson, Abbott, Talmage, and myself—disembarked from Her Majesty's ship *Urgent* on the 14th inst., and all but the three last mentioned proceeded to Estepona, a village in Spain, about 30 miles north-east of Gibraltar, and situated in the central line of totality, in Her Majesty's ship *Pigeon*, which had been kindly detained here by Captain Phillimore, R.N., the senior naval officer, to aid us in case of need. By this division of the party an additional chance was afforded of observing the phenomenon in case of bad weather, and Estepona offered the advantage of some 13 seconds' longer time of total obscuration than Gibraltar, a condition very desirable for the particular class of observations required by some of the party. The weather at Gibraltar was wet and cloudy almost from the time we landed until the day before the eclipse, when a strong breeze W. by N. gave a beautifully clear sky, which lasted till about midnight. Mr. Talmage, the director of the Leyton Observatory, and I, after consulting with those who knew the locality, determined to observe from the Moorish castle if the atmospheric conditions of the 21st should hold good on the 22nd, the day of the eclipse; but I arranged, through the kindness of Colonel Maberley, C.B., the commanding officer of Royal Artillery, to receive constant telegrams of the weather from Europa Point on the morning of the 22nd, and conveyance was provided to move the instruments at the latest practicable period, in case any other position afforded better chances of success. Mr. Talmage was to take angular measurements of Saturn, if seen through the corona, Mr. Abbott to sketch the corona, and I was to examine it with a polariscope. The westerly wind increased in force on the 22nd, but brought with it scud and dense clouds across the Bay from the Spanish mountains; everywhere these clouds were massed in the sky, separated by small intervals of hazy blue. The last telegram was received from Europa at a quarter past 11, forty minutes before commencement of totality, stating 'sky quite overcast, heavy clouds moving south-east, sun hardly visible.' This, together with the circumstance that the Rock did not appear to affect the clouds which were moving under the influence of a westerly wind, led me to conclude that the chances of good vision were equal at any position on the Rock. After waiting on the Line Wall for these telegrams, at which place I failed to observe the first contact, while Mr. Talmage failed in the same endeavour at the Moorish castle, I joined him there, leaving Mr. Abbott with his telescope erected on the flat roof of a house about a quarter of a mile west of the castle. The castle is a ruin about 300 ft. above the sea, commanding an extensive view of the Spanish mountains in the direction of the path of the shadow of the eclipse, and it has a clear look-out towards the south. The cloud which caps the Rock of Gibraltar, the summit of which is 1,396 ft. above the sea, during east winds, or Levanters, leaves this comparatively low level clear. On the castle platform with us were Captain Phillimore, R.N., Lieutenant Todd, R.E., who throughout have greatly assisted us, and other officers. About 30 seconds before the commencement of totality, a hazy blue break in the clouds enabled us to see the thin bright crescent of the sun, but unfortunately this patch of hazy blue sky, which favoured others for a few seconds, came a little too early in front of our position, and it was followed by a dense cloud, behind which the entire phenomenon of totality was hidden from us. The darkness was considerable, but not so great as when I observed the total eclipse of 1860, at Nisqually, in an unclouded sky. Then a lamp was necessary to enable a white-faced pocket chronometer to be read; yesterday I could see the divisions distinctly at the distance of eight inches without such aid. Mr. Abbott had the good fortune to see the corona and some red prominences, but only for about two seconds before they were lost in the same dense cloud; he estimated the breadth of the corona at about a sixth part of the moon's radius. Professor Newcomb, of the United

States' Navy, was able to see all four contacts, and to take several measurements that were necessary for the work he has in hand; he also caught a glimpse of the corona, but said he could make no use of it."

A Correspondent of the *Gibraltar Chronicle*, December 26, who was a casual observer of the total eclipse at Windmill-hill, sends the following notes, which are much fuller than those which other observers were enabled to make:—

"As the moment of 'totality' approached, and the moon's shadow, perceptibly travelling from west to east across the sun's disc, veiled his light more and more, earth and sky began to assume a weird unnatural aspect; and the effect was so solemn and fascinating that it was with painful anxiety one saw one of the dense clouds, with which the sky was largely covered, moving speedily from the west in the direction of the sun and threatening to hide the whole phenomenon. Heavy and looming, on it came, and at seven minutes before totality the view was completely lost. It was fortunately blowing hard. The friendly gale soon swept off the interloper, and at about four minutes before the eclipse the brilliant crescent again appeared. At 11h. 54m. 30s. (1½ minutes before totality), the clouds having left a considerable space of pretty clear sky, an extensive halo of deep shadow with a faintly luminous fringe of prismatic rays became visible. It was concentric with the sun, and in diameter about one-third of the arc between the zenith and the horizon, seemingly about 50 times the apparent diameter of the moon's shadow. This halo, visible only for half a minute, was effaced by another cloud, which again obscured the view. After a minute's breathless anxiety the 'curtain again rose,' revealing the longed-for *tableau*, a grand, impressive sight! It presented itself through a rent in the clouds not greater in area than ten times that of the disc of the moon's shadow. That part of the opening which was above the eclipsed orb was clear like the sun at twilight, and in it were visible to the naked eye the planets Venus, Mercury, and half a dozen stars. The remaining part was covered with a thin haze. The moon's shadow appeared to the eye, assisted by a somewhat weak binocular glass, to be a dark circular disc with an even boundary and of uniform shade. Within the corona, and touching the circumference of this shadow, appeared five or six spots of brilliant carmine, varying in form and size and at irregular distances apart. Two of these spots, or 'red flames' as they are called, on the eastern side of the disc, and at about 55 degrees and 80 degrees respectively from the vertex, seemed decidedly the largest and most prominent; they were tongue-shaped, and protruded about one-sixth the width of the corona. In their neighbourhood the corona was brightest and widest. There, too, the rays of the corona appeared to be gathered more distinctly into groups than elsewhere, faint shadows being visible between the groups. The corona consisted of brilliant rays of extremely faint prismatic hues; these rays at first sight appeared pretty evenly distributed all round, but closer examination seemed to detect the fact of there being bundles of rays in nearly regular groups. The width of the corona was about one-eighth the apparent diameter of the moon's shadow. It was very nearly concentric with the disc of the shadow; its boundary was well defined but 'jagged;' the perimeter, except opposite the two most prominent red flames above-mentioned, where the boundary slightly protruded, was circular. It was blowing a gale of wind while these notes were taken, which interfered somewhat with the steadiness of one's sight, either naked or assisted by glasses; they were jotted down, moreover, by an individual by no means 'well up' on the subject, and must, therefore, be taken only for what they are worth, which very likely is nothing—and it is only because so few people on the Rock, scientific or otherwise, were enabled to get a view of this rare phenomenon that they are now offered for perusal."

From Cadiz another correspondent kindly writes to say that Lord Lindsay succeeded in taking several excellent photographs from a vineyard belonging to Mr. Campbell, half way between Port St. Mary's and San Lucar.

The American party at Zeres saw the totality for about a minute.

From Seville comes the following, sent by E. A. De Cosson:—

"3, Calle Mason del Moro, Seville, Spain, Dec. 23.

"The morning of the 22nd was windy and cloudy, but not enough so to obscure the sun from sight for more than a few seconds at a time. At 10.30 A.M. (Seville time) the eclipse began, the upper right-hand side of the sun's disc being first covered. At 10.45 one-sixth of the sun's diameter was obscured. At 11.15 one-half, and at 12 the eclipse was total, the last bit of light disappearing on the left-hand upper side of the sun's disc. The shadow, therefore, obscured one-sixth of the sun's diameter every fifteen minutes At 12.10 it began to rain, and the sun was lost to sight until the conclusion of the eclipse, which occurred at 1.30 P.M. The eclipse was total for 70 seconds, and the effect was very striking, the whole sky becoming of a lurid purple and very dark. The birds were hushed and frightened, and the charcoal burners' fires in the mountains, some five leagues distant, were plainly visible."

THE ECLIPSE EXPEDITION AT ORAN.

The following very interesting letter (slightly abridged) is from the *Times*, January 3rd, 1871:—

"Bad weather rendered useless the elaborate preparations which had been made at this station to observe the total solar eclipse of Thursday, the 22nd ult. It may, however, interest your readers to have some account of the very complete arrangements which were made at Oran for attacking one of the great remaining problems of the sun's constitution—namely, the nature of the glow of light seen about the moon when it covers the sun at the time of a total solar eclipse. It has been long known that the sun as it appears in the heavens does not constitute the whole of that wonderful body, but that around it are less luminous portions which are usually concealed from view in consequence of the light scattered by our imperfectly transparent atmosphere. The illuminated atmosphere forms a brilliant screen which hides from view some less luminous appendages belonging to the sun. When the moon cuts off the sun's light before it reaches our atmosphere, not only is the disc of the sun obscured, but our atmosphere receives no light, and is therefore no longer luminous. As the moon appears but little larger than the sun, these outlying appendages, at other times invisible, are seen surrounding the moon. These consist essentially of two distinct phenomena, huge red flames extending frequently 60,000 to 80,000 miles from the sun's limb, and a glow or aureole of light, named the corona, from which curved rays and streamers have been seen to extend in several directions. The observations of Janssen, Major Tennant, and Lieutenant Herschel during the total eclipse of 1868 in India, revealed to us the true nature of the red flames, that they consist of great cyclonic storms or whirlwinds of luminous hydrogen; and by means of the spectroscope these objects can now be studied at any time when the sky is clear.

"The nature of the other phenomenon—namely, the coronal light about the moon, is still unknown. Is it a luminous atmosphere about the sun? Is it masses of meteors, or other bodies close about the sun, which reflect his light, as the floating motes in the atmosphere render visible the path of a sunbeam? Lastly, as some persons imagine, can this light be caused in any way by solar light reflected or scattered by our own atmosphere? The nature of the corona, therefore, was the great problem which had to be attacked. The methods of attack arranged for were three. First by the spectroscope, second by the polariscope, third by direct observation in a telescope. The first engine of attack, the spectroscope, would tell us if this light was similar to ordinary solar light, or if it consisted of light like that from a white-hot iron, or like that from a luminous gas. In the former case the corona would be due to the sun's light reflected from something almost certainly about the sun, though this observation by itself would not meet the objections that might be suggested by those who imagine that such a phenomenon could be produced by reflection from our own atmosphere. In the other cases the corona would be shown to be a self-luminous solar atmosphere. The polariscope enables the eye to detect light that has suffered reflection, and also to determine relatively the position of the source of the light. If, therefore, the coronal light were found to be polarised in a plane passing through the sun, we should know that it had been reflected from matter existing about the sun.

"The party placed in charge of Dr. Huggins, F.R.S., consisted of Admiral Ommanney, C.B., F.R.S., Mr. Crookes, F.R.S., Rev. F. Howlett, Captain Noble, Mr. Carpenter (of the Greenwich Observatory), Lieutenant Collins, R.E., Lieutenant Ommanney, R.E., Mr. Hunter, and Professor Tyndall, F.R.S., who accompanied the Expedition. The Expedition left Portsmouth on the morning of December 6, in her Majesty's transport ship the *Urgent*, in company with the parties intending to observe at Cadiz and Gibraltar. After encountering some heavy weather off Cape Finisterre, the *Urgent* anchored within the Mole at Oran at midnight on Friday, December 16. The astronomers were received with the greatest possible courtesy by M. Le General Des Messanges and M. Lambert, Prefet d'Oran; and M. Rocand, ingénieur en chef des mines, most kindly accompanied Dr. Huggins to several positions near Oran, which he considered the most suitable for the erection of the instruments. M. Janssen, so distinguished by his spectroscopic observations of the red flames in 1868 in India, had arrived at Oran, having escaped from Paris with his instruments in a balloon.

"A station was chosen near the railway station, about two miles and a half from the port, on ground selected, belonging to an Englishman resident at Oran, Mr. Hinshelwood, who most liberally placed the whole of his land at the service of the Expedition; the tents and poles, and cases of instruments being conveyed to the selected site at Oran. In the principal tent were erected two equatorial telescopes—one of 6 in. aperture, driven by clockwork, and one of 4 in. aperture. These were furnished with a new form of spectroscope, devised by Dr. Huggins in conjunction with the opticians, Mr. Grubb and Mr. Ladd, by whom the instruments were constructed. With these instruments the dark or bright lines which might present themselves in the spectrum of the corona could be instantly recorded by sharp pointers on a card, which could be so moved as to receive in succession the record of five spectra. This apparatus was found to answer so admirably that spectra could be easily recorded in from 10 seconds to 15 seconds. The great importance of this arrangement will be obvious when it is remembered that the totality would last only 2m. 11s. Dr. Huggins placed himself at one of these instruments, and Mr. Crookes at the other, whilst the telescopes to which the spectroscopes were attached would be directed to different portions of the corona by the skilful hands of Captain Noble and the Rev. F. Howlett. Outside the tent Lieutenant Collins was armed with a polarimeter, specially constructed to enable him to discriminate between the polarised light of the corona and the polarised light from our atmosphere. This instrument was attached to a 6-in. equatorial lent by Mr. Slater. Captain Salmond was prepared to observe with a similar instrument, attached to a 2½-in. telescope lent by Mr. Ladd. Mr. Carpenter was to observe and draw the form and appearance of the corona, with the aid of a 3-in.

equatorially mounted telescope. Admiral Ommanney and Lieutenant Ommanney were prepared to draw the phenomena as seen in the telescope on cards arranged for the purpose. A photographer, with a camera arranged so as to follow the sun's motion, was ready to obtain views of so much of the corona as would impress itself on the sensitive collodion. Professor Tyndall had established himself on a neighbouring fort with a 5-in. telescope by Dallmeyer, which had been used by M. De la Rue at the total eclipse in Spain. Lieutenant Walton, of the *Urgent*, and several other officers, were upon the ground armed with telescopes. It seems not too much to say that if the weather had permitted the sun to be visible at the proper time, there would have been no difficulty, with the instruments provided, in obtaining full and certain information of the nature of the coronal light. Alas! it was not to be. The earlier stages of the eclipse were seen, and a photograph taken, but ten minutes before totality a dense bank of clouds came over the sun, which extinguished all hope and rendered useless the laborious preparations of many weeks. M. Janssen was of course equally unsuccessful. Though the darkness was almost appalling as it rapidly increased up to the moment of totality, still the scene was deprived of a large part of its impressiveness by the dense mantle of cloud which concealed nearly the whole heavens."

Dr. F. G. Bergmann has, in his *Résumé d'Études d'Ontologie Générale*, &c., projected, from his own consciousness, the beings from which the human race developed itself. Their name is "Anthropiskes," and they lived in Central Africa. They developed out of apes; and a certain number of them, finding themselves in favourable circumstances, developed into men—black men, and became the parents of the families whence the brown, copper, yellow, and white races branched off. Dr. Bergmann has some equally original ideas on language. He complains that his works have not yet been appreciated, or even discussed, but he looks to the science of the future to do him justice.

METEOROLOGY OF 1870.

Monthly Means of Results for Meteorological Elements at the Royal Observatory, Greenwich, in the year 1870.

1870	Mean Reading of the Barometer	Temperature of the Air							Mean Temperature of Dew Point	Mean Elastic Force of Vapour	Mean Weight of Vapour in a Cubic Foot of Air	Mean Additional Weight required to saturate a Cubic Foot of Air	Mean Degree of Humidity (Saturation=100)	Mean Weight of a Cubic Foot of Air	Mean Amount of Cloud 0–10	Rain			Wind											
Months		Highest	Lowest	Range in the Month	Mean of all the Highest	Mean of all the Lowest	Mean daily Range	Mean Temperature								Number of Rainy Days	Amount collected on the ground		From Osler's Anemometer										From Robinson's Anemometer
																	Gauge read daily	Gauge read monthly	Number of Days for Mean Direction of the Wind referred to different Points of Azimuth								Number of Calm Days and days on which the pressure of the Wind was less than ¼ lb. on the square foot	Mean Daily Pressure in lbs. on square foot	Mean daily Horizontal Movement of air in Miles
																			N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.			
	In.	°	°	°	°	°	°	°		In.	Grs	Grs		Grs.			In.	In.											
Jan. .	29·823	50·9	19·6	31·3	42·6	34·0	8·6	38·3	34·1	0·196	2 3	0·5	85	555	6·5	15	1·49	1 58	2	5	2	3	4	9	3	1	2	0·69	297
Feb. .	29·693	55·6	19·4	36·2	41·4	31·9	9·5	36 2	29·7	0·165	1·9	0·6	78	555	7·4	13	0 54	0 60	1	8	2	3	6	5	2	1	0	0·88	259
March	29·865	61·1	23·1	38·0	46·9	34·0	12·9	39·6	34·7	0 201	2·3	0·5	83	554	7·5	11	2 05	2·15	5	11	1	1	2	5	2	4	0	0·42	310
April	29·984	78·7	26·0	52 7	62 0	38 4	23·6	48·9	39 2	0·239	2 8	1 2	69	546	4·0	6	0·28	0·24	3	1	3	2	2	9	5	3	2	0·17	239
May .	29·896	85·4	29·8	55·6	66·9	42·0	24·9	53·4	45·1	0·301	3·4	1·2	73	539	5·6	5	0·47	0·37	3	4	3	3	1	12	2	2	1	0·41	255
June .	29·947	90·2	41·4	48·8	74·8	50 7	24·1	60·9	50·6	0 369	4 1	1·9	68	532	6·4	4	0·39	0·23	4	4	1	1	1	8	7	4	0	0·26	243
July .	29·818	89·7	44·8	44·9	73·1	56 0	22·1	65·4	55·0	0·433	4·8	2·1	70	525	6·6	10	2·01	1·93	2	5	3	2	1	9	6	3	0	0·18	223
Aug. .	29·804	81·0	41·0	40·0	72·6	53·1	19·5	61·1	52·0	0·388	4 3	1 7	73	529	6·2	10	2 02	2·00	7	8	2	1	1	5	3	4	0	0·29	240
Sept. .	29·906	72·6	37·4	35·2	66·8	46·4	20·4	55 7	50 5	0 367	4·1	0·8	83	537	4·3	8	1 63	1·70	1	5	5	2	2	9	4	1	1	0·36	229
Oct. . .	29·570	68·6	32·4	36·2	58 2	42·8	15·4	49 8	45 3	0 303	3·5	0·6	85	537	6·2	16	3·34	3 40	2	3	3	1	2	11	6	3	0	0·65	327
Nov. .	29·637	58·9	24 3	34·6	47·8	35·4	12·4	41·5	38·5	0 233	2·7	0·3	90	548	6 1	9	1·20	1·30	3	3	2	2	3	10	5	1	1	0·34	240
Dec. .	29·733	57·4	9 8	47·6	38 0	28·9	9·1	33·6	29 8	0·166	1·9	0·3	86	559	8·1	22	3 13	3 00	6	9	3	3	1	4	3	1	1	0·21	242
Means	29·807	70·8	29·1	41 8	58·0	41·1	16·9	48 7	42·0	0·280	3 2	1·0	79	543	6·2	129	18·55	18·50	39	66	30	24	26	96	48	28	8	0 41	267
																						Sums							

Explanation.—The cistern of the barometer is about 160 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of corrections from Mr. Glaisher's paper, in the *Philosophical Transactions*, Part I., 1848; and from the readings of the wet and dry bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Mr. Glaisher's *Hygrometrical Tables. Fourth Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in column 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that which would have been had no water been mixed with the air.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE, ART, AND LITERATURE, 1870.

James Syme, Professor of Clinical Surgery in the University of Edinburgh, and a distinguished practitioner and teacher. He was born in Edinburgh, in 1799, and educated in the High School and the University of Edinburgh; but showed, while yet a boy, his fondness for the sciences of chemistry, botany, and anatomy, of which he learnt all he could in every way. Becoming a medical student at the college, he was the pupil of Dr. Barclay in anatomy; but paid some visits to the French and German medical schools, attending the classes of Professor Rust, at Berlin, and of Baron Dupuytren, at Paris. Under Mr. Liston, sometime Professor of Anatomy at Edinburgh, Mr. Syme, during his own studentship, was entrusted with the task of demonstrating in the dissecting-room. He was but twenty-two years of age when Mr. Liston quitted the professorship, and Mr. Syme began a course of lectures. These were, at first, upon anatomy; then upon surgery, as well as anatomy; but, after a time, upon surgery alone. He started, in 1829, a private surgical hospital in Minto House, Edinburgh, where he commenced that system of clinical instruction which he carried on during forty years with such good success. In 1833 Mr. Syme was appointed Professor of Clinical Surgery to the University of Edinburgh. Mr. Liston then removed to London, and became Professor of the same faculty in University College, Gower-street. Upon his death, in 1847, Mr. Syme was invited here to succeed him. He did so, coming to London in February 1848; but finding that the Council intended him to deliver systematic as well as clinical lectures here, which would have imposed on him too great an amount of labour, he resigned in May 1849, and returned to the chair he had left at Edinburgh, which was still vacant. He continued to hold the professorship till his death. He was the discoverer, or, at least, the first and best expounder, of several important scientific doctrines with regard to inflammation, ulcers, and gangrenes, the healing of wounds and the repair of bone; also, of some valuable processes in the treatment of various diseases and injuries of the body. As a practical surgeon he was renowned for his great knowledge, quick and safe judgment, courage, and singleness of purpose, ingenuity of contrivance, and skilful execution.

Sir James Clark, Bart., M.D., F.R.S., and more than thirty years chief physician of Her Majesty. Sir James Clark, who died at the age of 82, was born in 1788, in Banffshire. His education commenced at the Grammar School of Fordyce, and he subsequently studied medicine at Aberdeen and in the University of Edinburgh. After spending some time in the navy as an assistant-surgeon, he visited the schools of Italy, France, and Germany, and especially directed his attention to the medicinal virtues of the waters of certain noted mineral springs, and the sanative influence of climate. It was at this time that he obtained the appointment of travelling physician to a nobleman, which ended in his visiting Rome, and settling there in 1819. He soon became famous by his treatment of consumptive patients, so much so that he was very generally styled at an early period of his residence at Rome the "lung doctor." It was during the time that he practised at Rome that he became acquainted with Prince Leopold of Saxe-Cobourg, who subsequently appointed him his physician, when Sir James (then Dr. Clark) shortly afterwards returned to England. His return to this country from Rome was the consequence of a requisition signed by many of the most distinguished members of the English nobility and gentry being presented to him and calling upon him to leave Rome and settle in England. This he reluctantly complied with, and he soon acquired a most extensive practice, more particularly in affections of the chest. Sir James Clark published in 1829 a work *On the Influence of Climate in the Prevention and Cure of Chronic Diseases.* The views which he herein, and in subsequent editions, expressed, gave a decided impetus to the study of medical topography and meteorology, and the results will probably be far greater in the future than they have already been. Other works of a kindred kind followed. When the University of London was established, Dr. Clark took a leading part in the administration of its affairs; and the formation of the College of Chemistry was owing to his endeavours, and so was the origin of many important sanitary movements. In his earlier days Sir James was the warm friend and aider of Connolly, who did so much to do away with the barbarous treatment of the insane by mechanical restraints, and Connolly found in Clark a worthy biographer of his most humane and successful efforts towards the amelioration of the hitherto wretched treatment of the lunatic. Lastly, it may be mentioned that the views of medical reform which were promulgated some years since by Sir James, and especially in his famous letter to Sir James Graham, are consonant in great measure with the aspirations of the medical profession at the present.—*Abridged from the Times.*

NIEPCE DE SAINT-VICTOR, to whom the science and art of photography are so much indebted, was the nephew of Nicephore Niepce, the first inventor of photography. Niepce de Saint-Victor worthily sustained the name he bore, and his entire life was consecrated to researches and discoveries in photography. Amongst the numerous works we owe to him may be mentioned his researches to arrive at a means of fixing natural colours, in which he so far succeeded as to give them a relative stability, his essays upon the persistence of luminous activity, his heliographic processes, and above all, his obtaining the first negative upon glass, the invention which opened out a new era for photography, and prepared the way for the employment of collodion, the basis of all practical photography. There is, therefore, no photographer, French or foreign, amateur or professional, who takes a glass for the purpose of producing a picture who is not in the debt of Niepce. This invention might have been the source of a considerable fortune to its author if, less mindful of his own interests than of the progress of his art, Niepce had not generously abandoned to all the process which might have enriched him alone. This disinterestedness, alas! has not received its reward, for Niepce is dead, leaving behind him as his sole inheritance, a widow, two orphans, and fortune, less than nothing; for the emoluments arising from the position he held only sufficed for the support of his family. Regarding services received from him, regarding his death and his want of fortune, whoever draws profit or enjoyment from the inventions of Niepce ought to feel that he has a duty to fulfil, a debt to discharge. Therefore, sure of finding in all hearts the echo of these its own sentiments, the Society, established after the decease of Niepce, addresses itself confidently to all interested in the photographic art, and begs them to respond by a subscription." This circular is signed by Messrs. Davanne, Darlot, Ernest Lacan, and Fertier, the treasurers, and by M. Laulière, the secretary.—*Mechanics' Magazine.*

Dr. William Allen Miller, Treasurer of the Royal Society. Dr. Miller was born at Ipswich, in December 1817. He entered Merchant Taylors' School, and afterwards a school in Yorkshire, where, by listening to chemical lectures, he is said to have first felt an inclination for science. He subsequently studied medicine at the General Hospital, Birmingham; then worked for a while under Liebig at Giessen, and eventually became demonstrator of Chemistry in King's College, London. There he was held in much esteem by the then Professor of Chemistry, Dr. J. F. Daniell, to whom he succeeded in 1845. Besides this appointment, Dr. Miller was one of the Assayers to the Royal Mint. He was elected to the honourable post of Treasurer to the Royal Society in 1861; and served a term as President of the Chemical Society, of which he was a distinguished member, and was a member of the Senate of the University of London. His scientific writings comprise papers in the *Philosophical Transactions* and other serial works on electrolysis, on lines in the prismatic spectrum, on electro-chemistry, on the photographic transparency of various bodies, and other chemical subjects; and in conjunction with the late Professor Graham and Dr. Hofmann, he drew up the Chemical Report on the supply of water to the metropolis. But his greatest work was *Elements of Chemistry*, in three volumes, now in the third edition. Dr. Miller left London to attend the meeting of the British Association at Liverpool, 1870, and was observed to be not in his usual health. He died there of apoplexy on September 30.

John Shaw, F.S.A., the attached architect at Christ's Hospital, London, and one of the earliest members of the Royal Institute of British Architects. Mr. Shaw finished the interior of the Church of St. Dunstan-in-the-West, Fleet-street, designed by the above architect's father, John Shaw, F.R.S. and A.S.A., but which he did not live to finish, he having died on the twelfth day after the external completion of the edifice. The late Mr. Shaw, the son, designed the Law Life Insurance Office, Fleet-street, in the style that prevailed between the last period of Pointed architecture (of which St. Dunstan's is an example) and the complete revival of the architecture of Greece and Rome.

Thomas Brewer, a somewhat notable man, long connected with the Corporation of the City of London, was held to be a person of fine literary and antiquarian tastes, and who, for more than a quarter of a century, acted as secretary of the City of London School, Milk Street, Cheapside. He was born in 1807. At the early age of sixteen he entered the Town Clerk's office as a clerk, in which capacity he soon became remarkable for his aptitude in reading and translating ancient muniments of the Corporation bearing upon its franchises and peculiar privileges. In 1836, when a Bill was introduced into the House of Lords by Lord Brougham for re-establishing the City of London School on a new footing, but still in the spirit of its original founder—John Carpenter, a famous Town Clerk of London in the reigns of Henry V. and Henry VI.—and which measure resulted in an Act of the Legislature, Mr. Brewer rendered conspicuous public services, and especially to the Corporation, in investigating the circumstances under which the original bequest of Carpenter was made, upwards of 400 years before, and in deciphering the black-letter documents in which it was contained and perpetuated. While so engaged he also collected for the members of the Corporation some particulars of considerable public interest as to the personal history and character of Carpenter, a most remarkable man in many respects, a personal friend and eventually executor of the famous Sir Richard Whittington, and who twice represented the City of London in Parliament. The benevolent bequest of Carpenter had for its original object the clothing, boarding, and education—first at an elementary school, and afterwards at one or other of the public Universities—of "four poor men's sons," from time to time, and to that purpose he dedicated for ever real property of adequate amount. Towards the end of the first quarter of the present century that property, vested in the Corporation in trust, had acquired great additional value by the lapse of time, and vastly beyond the requirements for which it was originally destined by the testator. That bequest, so modest by comparison with its eventual results, formed at length the basis on which the City of London School was established on something like its present footing in 1837, and there now, instead of "four poor boys," as originally contemplated by the testator, more than 600 are being educated. For the services rendered by Mr. Brewer at that time the Corporation appointed him secretary of the school, an office which he held until his death. In 1856, from the materials which he had previously collected, Mr. Brewer wrote, at the express request of the Court of Common Council, a memoir of the life and times of Carpenter, which is acknowledged on all hands to be the most complete and authentic record extant of that eminent citizen, and he dedicated it to Sir David Solomons, the then Lord Mayor, and to Mr. Alderman Hale, the founder of the school on its enlarged footing, and chairman of its managing committee. He likewise contributed several interesting papers on subjects of antiquarian interest to one or other of the principal archæological journals.—*Times.*

JOHN W. COLE, best known by his *Life of Charles Kean*, and his *Memoirs of British Generals distinguished during the Peninsular War.* Originally in the army, and in the 21st Fusiliers, he was for some time lessee of the Dublin Theatre Royal, where he also distinguished himself as an actor. Subsequently he became secretary to Mr. Charles Kean, who held him in high esteem. Of late years Mr. Cole confined himself chiefly to magazine writing, and his articles on the Drama in the *Dublin University Magazine* were popular.

JULES SABATIER, the well-known numismatist at Paris. For many years in Russia, he founded the Numismatic and Archæological Society of St. Petersburg. He is a great authority, and a careful writer on Byzantine and Crimean coins.—*Athenæum.*

THE REV. PROFESSOR BARKER, of Birmingham, connected with Spring Hill College from its commencement. For many years he was resident professor, and during a considerable part of that time lectured on Classics, Hebrew, and Syriac. For rather more than 12 months he had ceased to reside at the college, but continued to have charge of the Hebrew classes and of the classes in Old and New Testament Exegesis. In former years he was well-known as a preacher to the Congregational Nonconformists in the principal towns in the Midland Counties.

DR. BISCHOF, the well-known German chemist and geologist. He was born near Nuremburg, in Bavaria, 1792, and received his education in the University of Erlangen, where he applied himself at first to the study of mathematics and astronomy, though he subsequently abandoned this branch of science, and, turning his attention to chemistry, became one of the most distinguished pupils of Professor Hildebrandt. In 1819 he was appointed Professor of Chemistry and Technology in the University of Bonn. An enthusiastic geologist, Dr. Bischof sought to discover in molecular action certain geological phenomena. His most important works are *Physico-Statistical Descriptions of the Fichtelgebirge Mountain*, published in 1817; *The Mineral Springs of Volcanic Origin in France and Germany and the Mineral Springs of Roisdorf*, and a *Treatise on the Interior Heat* *of the Terrestrial Globe.* The latter work, which appeared at Leipsic in 1837, was "crowned" by the Scientific Society of Holland. Dr. Bischof was a constant contributor to various scientific journals. His memoir on the *Mode of Preventing Explosions in Coal Mines*, published in 1840, gained the prize of the Academy of Brussels. Of his other works, the best known are a *Popular Letter to a Lady on the Natural Sciences*, 2 vols., Pforzheim and Bonn, 1840 and 1849; and a *Treatise on Geology, Chemistry, and Natural Philosophy*, Bonn, 1847-50.

JAMES WYLSON, architect, Islington.—He was one of the earliest contributors to the *Builder*; and an article by him which appeared in this journal for the year 1844, upon "Cements," attracted, among others from the same pen, considerable notice. He afterwards edited the *Engineer's Pocket Book*—a highly useful publication; and in 1859 appeared his *Mechanical Inventor's Guide*—a work containing a mass of condensed information, designed to form a practical introduction to the principles and components of machinery; being further illustrated by copious diagrams drawn by himself, and also a collection of nearly 300 mechanical movements. Mr. Wylson was born at Glasgow in 1811, and served an articleship of five years to an architect in that city, of the name of Weir, with whom he remained for four years longer. In 1836 he removed to Norwich, and for a brief time assisted Mr. John Brown, a well-known architect residing there. Upon arriving in London shortly afterwards, he was engaged by Mr. Sydney Smirke as a senior clerk in his office, where he remained till the year 1843. Mr. Wylson, in 1842, was one of a few "architectural draughtsmen" who formed themselves into an "Association," with that gentleman at their head, Mr. Wylson being both the originator of the movement and its first secretary. The association first held its meetings in Castle-street, Holborn; next in Southampton-street, Strand; then at Lyon's-inn Hall (also in the Strand, and since pulled down); and now, in a more developed form, it is known as the "Architectural Association," meeting in Conduit-street, Regent-street. Mr. Wylson designed and carried out many important public and private works in Glasgow, among which may be mentioned, an extensive range of "model dwellings for the labouring classes," the Prince's Theatre (since cleared away, the site being otherwise required), and St. Luke's Free Church. To the pulpit in the latter edifice he successfully applied, in 1855, the theory of the parabolic form as a sound-reflector. He also assisted in establishing the Glasgow Athenæum. In 1848 he received, out of 100 designs, the first premium for a plan for laying out the lands of Gilmore Hill for building purposes. His first engagement in the metropolis appears to have been a responsible post in the office of the late Sir C. Barry. He was subsequently Surveyor to the Conservative Land Society, which office he continued to hold until his death.—*Abridged from the Builder.*

E. W. Brayley, F.R.S., Pupil of the Royal Institution under Professor Brande. He joined the staff of the *Philosophical Magazine* and the *Zoological Journal* in 1822: to both he contributed many original papers and notices on chemistry, geology, zoology, and astronomy. His papers upon Meteors and Meteorites attracted attention, as well as his late papers upon the Constitution and Functions of the Sun, and Sources of its Heat and Energies, published in the *British Almanack and Companion.* He was librarian and lecturer at the London Institution: he gave for several years a systematic course of lectures upon geology, palæontology, and astronomy. He also lectured at the Royal Institution on Volcanoes and Igneous Geology; and to the readers of the Institution he was ever ready to give assistance in any scientific investigation.—*Builder.*

Professor J. Redtenbacher, the well-known Austrian chemist.

D. O. Hill, R.S.A.—He was born in 1802, at Perth, where his father was a bookseller. In 1823 he exhibited in Edinburgh three pictures of Scottish scenery, which evinced artistic skill of high promise. In 1830 he was appointed secretary of the new Royal Scottish Academy. He was the first to suggest the formation, and aided in devising the constitution of the Royal Association for the Promotion of the Fine Arts in Scotland.

M. Villemain, the venerable Secretary of the French Academy, aged 79. M. Villemain had been engaged in literary pursuits from a very early period of his life, having been appointed a professor at the Charlemagne College when he was but 19 years old. Other appointments speedily followed, but a few years later he lost Imperial favour in consequence of his scruples to undertake a task in violation of his ideas of literary purity. This task was no other than to prepare a revised edition of the classics, from which should be omitted all maxims which were opposed to Imperialism; but M. Villemain indignantly refused to be the author of an expurgated *Cicero.* Under the Restoration he resumed his appointments, but after 1830 his progress was more rapid, and he filled the post of Minister of Public Instruction in the Cabinet of Marshal Soult. In 1834 he became secretary of the famous Academy, and in that capacity exercised for 36 years a very considerable influence in the conduct of the affairs of that august body, admission to which is the ruling idea of every Frenchman who adopts literature as a profession or an accomplishment. M. Villemain was a great admirer of Shakespeare, and had a perfect knowledge of English literature, with which he combined an extreme and almost ludicrous hatred of the Jesuits, which at one time caused an illness that threatened loss of reason, if not of life. Since 1848 he has not been known to the public save in his official capacity in connection with the Academy.

Professor Westermann, of Leipzig, was born in the year 1806. He studied at the University of his native city, and became a *privat-docent* and subsequently a professor there. Devoted nearly exclusively to the study of ancient literature, and more especially of the Orators, he early in life achieved a considerable reputation. His *History of Eloquence in Greece and Rome* is a work known to all scholars. He published *Quæstiones Demosthenicæ* (1830–37), an edition of *Philostratus* for the Didot Series in 1848, *Commentationes Criticæ in Scriptores Græcos* (1846–52), and many other works, among which we may mention the edition of the *Select Speeches of Demosthenes* in Haupt and Sauppe's Classics, and the text of *Lysias* in B. Tauchnitz's collection. Professor Westermann translated Colonel Leake's *Demes of Attica* in 1840.

HENRY GARLING, Architect, a member of the Royal Institute of British Architects. Mr. Garling was articled to Mr. Page, of King's-road, Bedford-row, who, as usual in that day, combined the business of architect, surveyor, and builder; and, for three years after his articles, Mr. Garling acted for him in superintending (in fact, designing and doing everything, Mr. Page never answering any letters), in the remodelling of Grimsthorpe Castle, in Lincolnshire, for Lord Gwydir (Willoughby d'Eresby). He became a student of the Royal Academy, and gained the silver medal in 1818. Architecturally, he was engaged extensively for Lord St. John of Bletsoe, Baron Vaughan, Earl Spencer, and the Carron Company, of Thames Street. The market-house at Guildford and the Holborn Union Workhouse were also designed and superintended by him. He retired from business in 1847. He had a fine library, and had become governor of Christ's Hospital, St. Thomas's, Bethlehem, and other institutions.

HENRY MOSES, the eminent engineer, aged 88 years 6 months.

JAMES MACQUEEN, well known, for many years a great labourer in the cause of African geographical exploration; and a tribute was paid to him by Sir Roderick Murchison in the anniversary address at the Royal Geographical Society on May 23. By Mr. Macqueen's death, we regret to learn, Miss Macqueen, his amanuensis and nurse, has been left utterly destitute at the age of 65. Sir Roderick Murchison has headed a subscription, which has been opened on her behalf, at the rooms of the Royal Geographical Society.

PROFESSOR HEINRICH GUSTAV MAGNUS, of Berlin. He was born 1802, was elected a member of the Academy of Sciences at Berlin in 1840, and in 1845 became Professor of Physics and Technology in the University of Berlin. His contributions to chemistry and physical science occupy a large space in Poggendorff's *Annalen*, in the *Monatsbericht* of the Academy, and in other periodicals; and in the great Catalogue now publishing by the Royal Society, he appears as the author of 66 different papers. Among these are researches on the penetration of heat-rays through gases and vapours; on phenomena of rotation, of absorption, of electric induction, besides numerous analyses. Translations of his papers have appeared in the *Philosophical Magazine*: and to the most advanced investigators of physical science in this country he has long been known as a worthy co-operator, one whose inquiries were alike profound, faithful, and trustworthy. Professor Magnus was elected a Foreign Member of the Royal Society in 1863. He was present at the Meeting of the British Association at Exeter in 1869.—*Athenæum.*

CAPTAIN COWPER COLES, R.N., the designer of H.M. turret-ship *Captain*, in the foundering of which he lost his life,* was the third son of the late Rev. John Coles, of Ditcham Park, Hampshire, and was born about 1819 or 1820. He entered the service in 1831, and, having served with ability on various stations, took an active part, on board H.M.S. *Agamemnon*, in the assault on Sebastopol, for which he was especially mentioned in the despatches of Lord Lyons. He subsequently distinguished himself by his zeal and ability at Kertch, and in the operations in the Sea of Azoff. In the following year his name was brought prominently before the nation by the appointment of a Board by the Commander-in-Chief to report upon a plan devised by Captain Coles for the construction of shot-proof rafts, with guns and mortars; and so favourable was the Report of the Board that, in the expectation of the continuance of the war, he was ordered to England and placed in communication with the Surveyor of the Navy and the authorities of the dockyard at Portsmouth. The cessation of the Russian War, however, for a time stayed further proceedings in the matter; but subsequently the matter was taken up by successive Governments, and eventually, as the naval authorities expressed their approval of the principle of the "shield-ship," orders were given that the *Royal Sovereign* should be adapted, under the superintendence of Captain Coles, to this method of construction. It was, we believe, in 1862 that this change to the "turret system" was effected in the *Royal Sovereign*; and it is stated that it was the late Sir I. Brunel who first suggested to Captain Coles the idea of placing the shield and gun upon a turn-table in preference to having to move the raft in order to point the gun. The principle having been once adopted, other vessels of the Royal Navy, as our readers are aware, have since been constructed on a greater or less modification of Captain Coles's plan. The long dispute waged by Captain Coles with the authorities at Whitehall on the turret question, and the acceptance by the Admiralty of Messrs. Laird Brothers as the builders of a vessel which should fully represent Captain Coles's views and their own of what an efficient seagoing cruiser on the turret principle should be, have often been the subjects of discussion. We need only remark here that the *Captain* was the result of these arrangements. The principal dimensions of the ship were: length over all, 335 ft.; between perpendiculars, 320 ft.; breadth, extreme, 53 ft. 8 in.; tonnage,

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* See also pp. 48 and 49 of the Mechanical Section of the present volume; and *Knowledge for the Time*, by the Editor of the present *Year-Book*.

4,272. Her machinery consisted of two separate pairs of double trunk engines, each pair driving independently a two-bladed screw of 17 ft. in diameter. The collective nominal power of the engines was 900-horse. The general plan of construction of the hull of the ship was on the cellular principle, as now adopted in all ships built for our navy, and she was divided into five water-tight compartments. The fore-end, or bows, of the ship were constructed as massively as possible, consistently with the weight to be carried, and the heavy wrought-iron stem would have been a powerful means for ramming, although it did not project so far in advance of the fore-body of the ship as do the submerged beaks of the rams *Rupert* and *Hotspur*. Each turret stood in its own water-tight compartment, which contained also the engines for moving the turret. The *Captain* was meant for a competitive ship with the Admiralty-designed cruising turret-ship *Monarch*. In outward appearance no two ships could well be more dissimilar. The *Monarch*, as the representative of the high freeboard type, carries her turrets on a deck elevated at an unusual height from the water, and thus offers in her lofty sides an immense and weakly-plated target—as compared with the penetrative power of her own guns—for an enemy's shot. With a low freeboard, and therefore offering a much lesser target, the *Captain* had greatly the advantage of the *Monarch* in this respect; but it had always been a question whether she would prove equally seaworthy—at least when fitted with heavy tripod masts and a great spread of canvas, and navigated as a sailing-vessel—in rough weather.—*Illustrated London News*.

THOMAS BRASSEY, the famous Engineer. He was born in 1805, at Boughton, in Cheshire, where his yeoman father occupied land which had been held by his ancestors during a couple of centuries. Articled to a local land agent and surveyor, Mr. Brassey here learnt the principles of commercial economy, and made his first independent start by contracting for the making of a road in North Wales. The first railway contract signed by Mr. Brassey was in 1836, when he took ten miles on the Grand Junction line between Birmingham and Liverpool, now incorporated with the London and North-Western Railway. The Penkridge Viaduct on the same line was his next great work, and at this date Mr. Brassey accompanied the late Mr. Locke, the eminent engineer, into the southern districts of England, where he executed large portions of the main South-Western line, and many of its branches. From the south-west district of England, Mr. Brassey was naturally led by the same engineer to the Continent, where in the early days of improved locomotion he constructed a large portion of the Western of France and the Paris and Rouen Railways, which in turn led to his contracting for important works in Belgium, Holland, Denmark, Norway. Spain, Savoy, Italy, and Austria; with all of which countries his name will ever be intimately associated. Many of these works—notably among others, the flying railway over

Mont Cenis—proved in a pecuniary point of view disastrous speculations to Mr. Brassey, but such was the largeness of the view he took of everything upon which he was engaged, and such his steadiness of purpose and integrity, that, although, in numerous cases where through failure of periodical payments it would have been easy to have relieved himself of unprofitable contracts, he never would avail himself of the *lâches* of others, and if his word had once been passed he always insisted upon carrying out his engagements to the letter. This was his course of conduct when, during the panic of 1866, he found himself associated with Messrs. Peto and Betts in many large works, which at that period were paralysed for want of capital. On the collapse of his partners in these undertakings, Mr. Brassey spontaneously took upon himself all the works with which his name had been connected, and personally carried them through to completion. The gigantic foreign and colonial operations in which Mr. Brassey was engaged for many years did not exhaust his energy, and while they were in progress a section of his large staff were always busy in the United Kingdom—at one time upon the Caledonian Railway, a remarkably difficult work, at another constructing the Welwyn Viaduct, upon the Great Northern Railway; then the West-London Extension line, including a bridge across the Thames at Battersea; then the Northern Mid-Level Sewer, and more recently Mr. Baker's great bridge across the Mersey at Runcorn, near Liverpool. A fair idea of the magnitude of Mr. Brassey's operations may be gathered from the fact that in the thirteen years from 1848 to 1861 inclusive, he made, either by himself or in association with others, 2,374 miles of railway, at a contract price of 27,998,224*l.* Mr. Brassey is stated to have suffered during the panic of 1866 to the extent of more than a million of money, but it is, perhaps, quite as extraordinary that in 1869 he is understood to have been a richer man than during any former period of his career. His existing contracts are now gradually running out. Indeed, his chief motive for continuing his business during recent years has been his knowledge of the fact that he had a very large staff dependent upon him, and that he did not like to see them out of employment. His loss will be greatly felt among his own class, whom he was never tired of assisting in the manner best calculated to be useful to themselves. Mr. Brassey married early in life Miss Harrison, of Birkenhead, who survives him, and by whom he leaves three sons—Mr. Thomas Brassey, M.P. for Hastings; Mr. Harry Brassey, M.P. for Deal; and Mr. Albert Brassey, who is an officer in the 14th Hussars.—*Times.*

Zerah Colburn, whose name is familiar not only to the mechanical profession, but to all who study scientific literature. Mr. Colburn's writings were brilliant and varied, and his sound practical experience and mechanical talent gave them a permanent value. Mr. Colburn was born at Saratoga, N.Y., in 1833, his father dying soon afterwards, and leaving his widow poor and infirm. During his boyhood, young Colburn earned his living on a farm in New Hampshire, but in course of time he found his way to Boston, where he attempted some verses for a local paper. He commenced his professional career on the Concord Railway, where the locomotive engine was his special study and charm. His extraordinary abilities soon developed themselves, and raised him to the superintendence of the locomotive works of Mr. Souther, in Boston. For a year or so he afterwards superintended the New Jersey Locomotive Works at Patterson, where he introduced several practical improvements in the engines. After this Mr. Colburn joined the New York *Railroad Journal*, and in 1854 he started the *Railroad Advocate*, which soon attained great popularity. In 1857, Mr. Colburn was commissioned, with Mr. Holley, by the presidents of several American railways, to visit Europe and report upon the railway system and machinery. Their Report was published in 1858, and refers chiefly to permanent way and coal-burning locomotives. In the same year, Mr. Colburn returned to London and became editor of the *Engineer*, returning to the States after a few years of hard work, and starting his own *Engineer* there. This paper, however, was before its time, and so fell through, upon which Mr. Colburn returned to London and resumed the editorship of the *Engineer*, which he retained up to 1866, when he started *Engineering*, his connection with which paper was only dissolved a few weeks before his death. Mr. Colburn also wrote a number of important treatises and valuable professional papers at various times, and commenced an elaborate work on the locomotive. Although a man of iron frame and strong constitution, intense application to work and irregularity in relaxation at length told upon him, and the last few months of his life were marked by a course which was clearly indicative of partial insanity. At last, the final crash came, the jarred and jangled mass of brain and nerve could hold out no longer, and he fell by his own hand, in the 37th year of his age, leaving a name which will stand as that of the best professional writer we have ever had.—*Mechanics' Magazine.*

J. D. Zocher, architect, of Haarlem, in his eightieth year. He had been for thirty years Honorary and Corresponding Member of the Institute of Architects, and had frequently communicated valuable information, as he took a deep interest in the success and operations of the Institute.

J. B. Pyne, the artist, who was for many years Vice-President of the Society of British Artists. Mr. Pyne was a native of Bristol, and, when a lad, was articled to an attorney. The law was not, however, to his taste, and he soon abandoned it to follow the more congenial pursuits with which his name has become associated. His views of the English lakes and his Italian scenes are the works by which he is best known.

William Essex, enamel-painter. He was born in London, 1785. His father was a watch dial-painter and bookseller, in

Clerkenwell, and in the former capacity gave that direction to his son's talents which grew to an ambitious desire to extend the application of enamel, and to transcribe the great masterpieces of art in this imperishable material, so that faithful records of them should be preserved long after the more fragile oil-colour, canvas, and panel should have succumbed to the injurious hand of time. The book department of his father's business enabled him to gratify his love of reading, and to enrich his mind with poetic and artistic lore; and was also the means of introducing the young aspirant to Flaxman, Brayley, Britton, and others, with whom his father was intimate, and who encouraged his early efforts and remained his steadfast friends. As a youth, he had very little formal instruction in art; he was, however, placed for a brief period with the very excellent enamel and glass-painter of the name of Muss, though his success and skill were more due to his own talent, industry, and perseverance. The *technical* excellence of his work at the commencement of his career may in a great measure be ascribed to the chemical knowledge of his brother, Mr. Alfred Essex, who prepared the *plates*, compounded the wonderfully choice colours, and *fired* the paintings; but his brother's health unfortunately failing, the whole onus of enamelling, technical as well as artistical, latterly devolved upon him. He had furnaces built at the back of his house in Osnaburgh-street, Regent's-park, and henceforward attended to the *firing* and the entire chemistry of enamelling himself. His earliest enamels of importance were small and delicately-finished portraits of George IV., executed for Messrs. Rundell and Bridge, jewellers to His Majesty. These brought him Court notice. He afterwards painted for William IV: and Queen Adelaide, and continued to exhibit from year to year at the Royal Academy and elsewhere. Thus he gradually gained many kind and influential friends and patrons among the nobility, and was introduced by the Duchess of Gordon to paint for the Princess, who, on becoming Queen Victoria, made him her enamel-painter in ordinary. His portraits of the Queen, his Royal Highness the late Prince Consort, and other members of the Royal family, are numerous, and he executed many of the enamels for that regal and interesting historical series of portraits from Henry VII. to the present time which adorn the chambers of Windsor Castle.—*Abridged from the Builder.*

ADOLPHE BOETTCHER, the German poet, at Leipsic, his native city. He was born 1815, and at the age of 21 entered the University of Leipsic, devoting himself to philological pursuits, and to the study of German and English poets. Among his numerous poetical productions, his translations of the English poets occupy a conspicuous place. In addition to the works of Shakespeare and Byron, he translated the poems of Goldsmith, Pope, Milton, and Ossian. Among his original works are *Agnes Bernauer* (a drama), *Songs of Midsummer*, *On the Watch Tower*, *A Tale of Spring*, *Till Eulenspiegel*, *Pilgrimage* *of the Flower Spirits*, *Shadows*, and a collection of smaller lyrics.

DANIEL MACLISE, R.A., distinguished painter.

W. MICHAEL BALFE, celebrated musical composer.

MARK LEMON, *littérateur*; one of the originators of *Punch, or the London Charivari*, and its able editor from its commencement, in 1842, to Mr. Lemon's death.

CHARLES DICKENS, the most celebrated novelist of his day.

LIEUT.-COL. PEMBERTON, formerly of the Coldstream Guards, but was killed whilst acting as military correspondent for the *Times*.

DR. JOHN BACOT, formerly of the *Medical and Philosophical Journal*.

JAMES EVANS, of the *Record* newspaper.

DR. MATTHIESON, an eminent chemist.

THE REV. THOMAS PHILLIPS, D.D., Senior District Secretary of the British and Foreign Bible Society.

JOHN TIDD PRATT, Registrar of Friendly Societies.

SARAH BELZONI, widow of the well-known traveller in Egypt.

JOHN WILSON, author of *Our Israelitish Origin*.

SAMUEL BAILEY, essayist.

GEORGE, EARL OF ABERDEEN, lost at sea on a voyage from Boston to Melbourne.

GEORGE HOGARTH, aged 86, musical critic.

SIR JAMES VALLENTIN, Sheriff of London and Middlesex.

WILLIAM HENRY BLAAUW, F.S.A., antiquarian writer.

THE EARL OF CLARENDON, distinguished statesman.

MURDOCK YOUNG, formerly of the *Sun* newspaper.

JOHN WILLIAMS, proprietor of the *Cambrian* newspaper

SIR JOHN THWAITES, first Chairman of the Metropolitan Board of Works.

ROBERT KANZOW BOWLEY, General Manager of the Crystal Palace Company.

CHARLES GREEN, the veteran aeronaut. His aerial chronology dates from July 19, 1821, when he made his first ascent in a balloon inflated with coal gas, which he substituted for hydrogen. This was one of the great out-door sights provided for the people in St. James's-park on the coronation day of George IV. Hitherto balloons had been inflated with hydrogen gas by a slow chemical process, made in casks, whence it was conveyed by hose into the balloon. Coal gas proved more economical as well as certain; and the success of Mr. Green vastly increased the facilities of balloon ascents. Between the above date and May 1850, Green made 142 ascents from London only. In the autumn of 1835, Green ascended from Vauxhall Gardens, and remained up during the night. Green descended at Walthamstow, where his companion left him, and Green took in his friend's weight of ballast, which would be more disposable in case of being carried out to sea. Next morning Green descended near Downham, in Suffolk; he then re-ascended, and finally came to anchor near the town of Lynn. "I remained," says Green, "in the air altogether about thirteen hours, and, from the zigzag direction of my course, must have travelled about 150 miles. From the very trifling loss of power the balloon sustained during the whole of the time, I judged that I might have remained up for at least five days and nights." In the following year, Green constructed for the proprietors of Vauxhall Gardens a vast balloon, 150 ft. in circumference, and 80 ft. in height when inflated and with the car attached. To inflate this balloon with pure hydrogen gas would cost about 250*l.*; with coal gas, about 70*l.*, at the high price of that day. The expense of constructing this vast balloon is stated at 2,100*l.*, the cost of the 2,000 yards of silk being 700*l.* On Sept. 9, 1836, Mr. Green made his first ascent in this balloon, taking with him three other persons named Green and five others, though there was buoyancy enough to have taken up twenty persons. The balloon crossed the Thames several times, and descended near Cliffe, in Kent. In the same year, Nov. 7, Mr. Green, Mr. Monck Mason, and Mr. Hollond ascended in this balloon, and in one hour from the time of quitting England were floating tranquilly, though rapidly, above the shores of our French neighbours. They descended at Weilburg, in the grand duchy of Nassau, in eighteen hours—the voyage exceeding an extent of 500 British miles. Provisions, which had been calculated for a fortnight's consumption, in case of emergency; ballast to the amount of upwards of a ton in weight, disposed in bags; together with an unusual supply of cordage and implements, occupied the bottom of the car; while all around the hoop and elsewhere hung cloaks, carpet-bags, barrels of wood and copper, coffee-warmer, barometers, telescopes, lamps, wine-jars, and spirit-flasks, with many other articles, designed to serve the purposes of a voyage to regions where, once forgotten, nothing could be again supplied. Of the voyage Mr. Monck Mason published a very interesting account. In July 1837, Mr. Green ascended from Vauxhall Gardens in his great balloon, with Mr. Cocking in his parachute attached. It resembles an inverted open umbrella; and when Cocking cut the connecting-rope from the balloon, the parachute collapsed, and he fell to the earth with great velocity, and was taken up dead at Lee, near Blackheath. The result had been nearly equally fatal to the persons in the car of Green's balloon, which shot up so rapidly that the gas was forced out; and for nearly five minutes they suffered great pain. Most luckily, they had provided a large silken bag full of atmospheric air, and furnished with two metal tubes; these they applied to their mouths, and were thus enabled to breathe. Without such a precaution, suffocation would have been inevitable. In the above month, Mr. Green, with two companions, made, in the Nassau balloon, an ascent to ascertain whether the same difficulties existed with regard to respiration in a very rarefied atmosphere by persons ascending with a balloon to any great altitude, as have been felt and described by persons who have ascended lofty mountains. The greatest altitude reached was 19,335 ft., or three miles and a half and 855 ft. At no period of their voyage did the aeronauts experience the slightest inconvenience in respect to difficulty of respiration; they breathed with the utmost ease and as freely as when walking on the earth's surface. On Sept 10, 1838, Mr. Green and Mr. Rush ascended from Vauxhall Gardens in the Nassau balloon, and descended at Lewes, in Sussex, having reached the then greatest altitude ever attained—27,146 ft., or five miles 746 ft. In 1840, Mr. Green purchased the Nassau balloon for 500*l.* Among other interesting results Mr. Green relates his experiences of the variety of currents in our atmosphere influencing the rates of his aerial travelling. At a great elevation he found the north-west current generally prevalent throughout the year, without reference to the direction of the wind near the earth; this constant current being at an elevation of from 13,000 ft. to 14,000 ft. This upper current carried his balloon at the rate of six miles an hour, whilst the lower current wafted it at the rate of thirty miles an hour. In one of his ascents from Liverpool he entered the constant current at an elevation of 14,000 ft., and descended into a lower south-east current at the height of 12,000 ft.—the former carrying his balloon at the rate of five miles, and the latter at the rate of eighty miles an hour. He thus travelled ninety-seven miles in fifty-eight minutes, and often at sixty to eighty miles an hour. Mr. Green's experimental results in steering balloons would occupy more space to detail than we can afford. The problem in aerial navigation which remains to be solved is, to move through the air in any desired direction. In August, 1847, he made a perilous ascent at Frankfort, when, just after a violent peal of thunder, the balloon rose almost immediately under the clouds from which the storm proceeded. When at about 4,500 ft. high, and on a level with them, several electrical discharges afforded the opportunity of observing the effect of lightning upon the air, as the clouds and the balloon were going abreast of each other at only a few hundred yards distance. After being up about an hour, the aeronaut descended at Windecken. The results of scientific balloon ascents made by Mr. John Welch, of the Kew Observatory, have been communicated to the Royal Society and the British Association, who acknowledge the admirable way in which Mr. Green managed his balloon, and the zeal and intelligence with which he went into the enterprise.—*Abridged from the Illustrated London News.* There is a mezzotint of Green (private plate).

SIR FREDERICK POLLOCK, BART., late Baron of the Court of Exchequer. Sir F. Pollock in the later years of his life applied practically to more than one branch of scientific pursuit the mathematical principles which he had imbibed at Cambridge. Thus, for instance, he took the greatest interest and delight in the pursuit of Photography, and was one of the very best amateur photographers of our time. He was an active member of the Council of the London Photographic Society, over the meetings of which at King's College he would frequently preside, down to a very recent date. He also contributed several papers upon his favourite study to the *Philosophical Transactions of the Royal Society.*

Professor Sir James Y. Simpson, of Edinburgh. Sir James was born in 1811, and was appointed in 1840 to the Professorship of Midwifery in the University of Edinburgh, for his discoveries in connection with chloroform, which are well known. Numerous honours were conferred upon him. Among these, it may be mentioned that in 1853 he was elected Foreign Associate of the French Academy of Medicine. In 1856 he was awarded the Montyon Prize of 2,000 fr. by the French Academy of Sciences. About the same time he received the Knighthood of the Royal Order of St. Olaf from King Oscar of Sweden. In 1866 he was created a Baronet; in the same year he received the honorary degree of D.C.L. from Oxford. In October last he was presented with the freedom of the city of Edinburgh, in "recognition of his scientific researches and applications of science to the alleviation of human suffering." Shortcomings, errors, and omissions occur in popular accounts of these researches and applications. One of these notes has reference to his great discovery of the anæsthetic power and use of chloroform in childbirth. That others preceded him in the use of ether in tooth-drawing, or even in other surgical operations, may, doubtless, be the fact, as it was, indeed, that Sir Humphry Davy had, many years before, called attention to nitrous oxide as a power which had wrapt him up, out of the fleshy and pain-feeling state, into the quasi-spiritual, and induced him, while in that state, to announce, as an "infallible" oracle, that "nothing exists but ideas." That Simpson, however, was the exclusive originator of the professional practice of destroying pain in childbirth, and had the idea, too, of doing so previously altogether to Morton the American dentist's professional experiments with other in 1846, the writer of the above note for one can testify. Between 1835 and 1840, Dr. Simpson steadily entertained the idea of using the "deep sleep' and pain-killing power of artificial entrancement in midwifery for the facilitation of the natural birth; while my object had a curious antithetical co-relationship to that, as it related to an investigation of the spiritual birth of the life of entrancement itself, which has since been more fully carried out at Glasgow and London.

The Venerable William Hale Hale, M.A., Archdeacon of London, and Master of the Charter House, in his 74th year. Archdeacon Hale was the author of a large number of works, among the most important of these, exclusive of *Sermons*, *Charges*, and *Letters* on current topics of the day, are an *Essay on the Division of Tithes in England*; *Remarks on the Probable*

Consequences of Establishing a General Registry of Births; the *Antiquity of the Church-Rate System Considered;* the *Pontifical Law on the Subject of the Utensils and Repairs of Churches; Institutiones Piæ*; a *Series of Precedents and Proceedings in Criminal Causes*; *Sick Man's Guide; Four Gospels, with Annotations*; *Duties of the Deacons and Priests in the Church of England compared, with Suggestions for the Extension of the Order of Deacons and the Establishment of an Order of Sub-Deacons*; *Past History and Present Condition of the Charter House*; *Some Account of Christ's Hospital.* He also brought out an edition of Bishop Jeremy Taylor's *Doctrine and Practice of Repentance* and the *Epistles of Bishop Hall*, and contributed to the *Encyclopædia Metropolitana* the articles on "Baptism," "Baptist," "Bishop," "Confirmation," and the "History of the Jews."

William Sidney Gibson, F.S.A., of Newcastle-upon-Tyne, the well-known topographical and antiquarian writer.

Philip Hardwick, R.A., architect of the new Hall of the Goldsmiths' Company, opened in the year 1836. "We believe that few modern English architects have left a better monument of their skill than this building."—*Builder.*

Alexander Munro, sculptor. He had no rival in the graceful and fanciful treatment of children. His portrait busts of women were distinguished for their refined and delicate sentiment. Above all, he was pre-eminently successful in his portraits in high and low relief—perhaps the most difficult style in the range of sculpture. He will also be remembered for his statues of Hippocrates, Galileo, Davy, and James Watt, remarkable for picturesqueness, concentration, and character. His first work of a mouumental kind is the colossal standing statue of James Watt, at Birmingham. Nor must be omitted Mr. Munro's out-door memorial marble statue, at Boston, of Mr. Herbert Ingram, M.P., who had fostered early the sculptor's genius. Mr. Munro, who died at the early age of forty-five, was, in his professional as well as in his social relations, a most gentle and unselfish man.

John Wood Papworth, a zealous student of art, remarkable for his skill in architectural drawing and artistic colouring, his knowledge of the arts and sciences, and his intimate acquaintance with the history and practice of his profession. He contributed many designs for glass, terra-cotta, paper-hangings, and other art manufactures, for the "Exhibition of the Industry of all Nations, 1851."

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